SEPTEMBER, 1961

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Volume 47, Number 9

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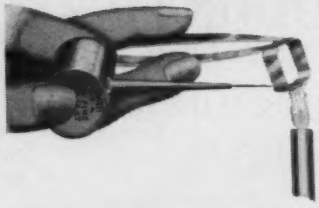

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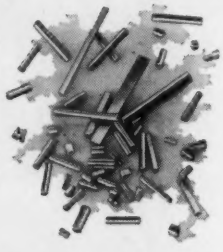

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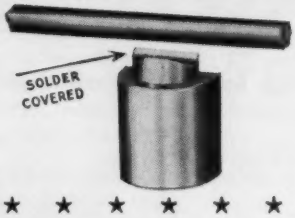

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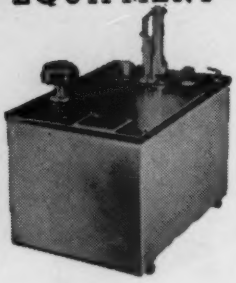

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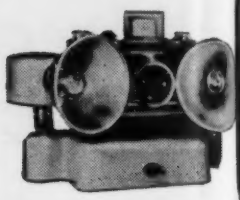

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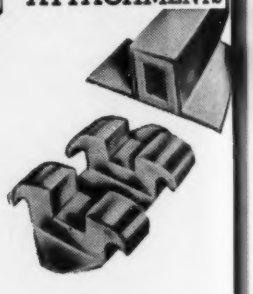

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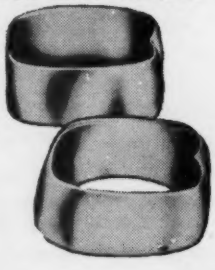

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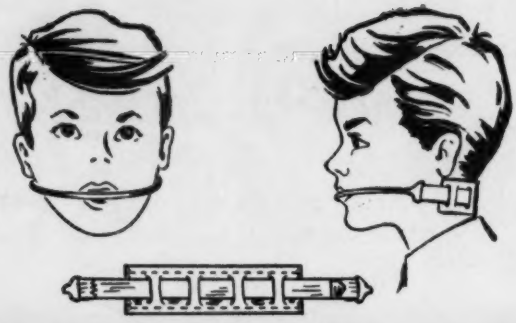

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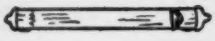

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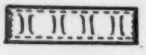

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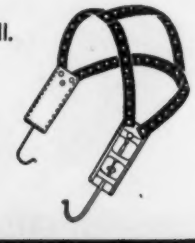

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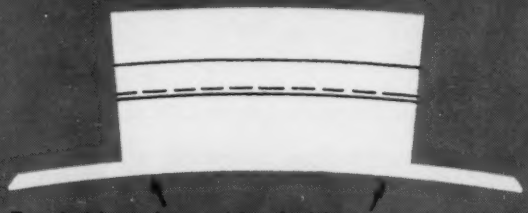

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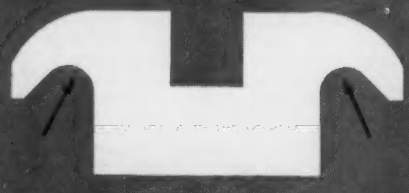

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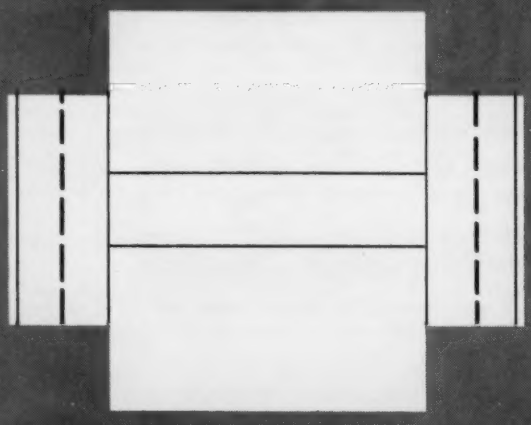

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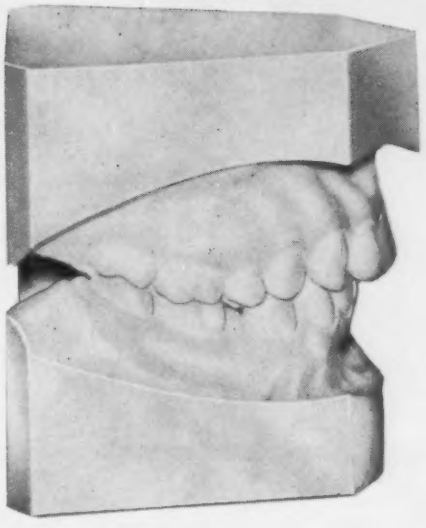

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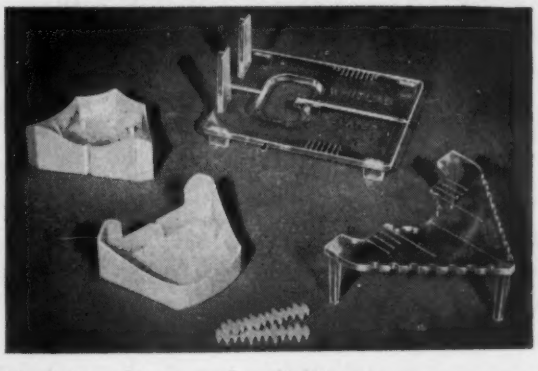

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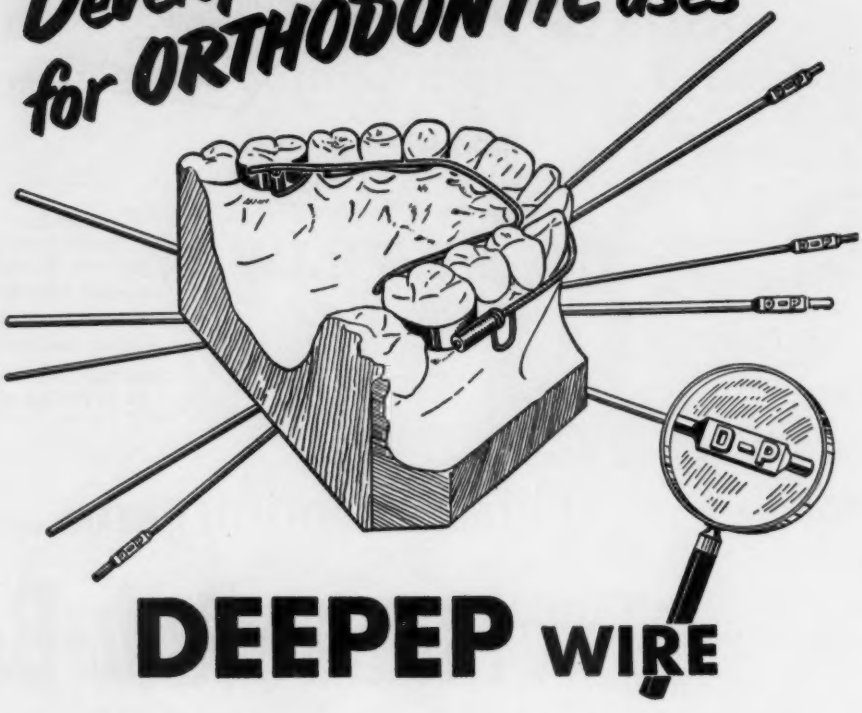

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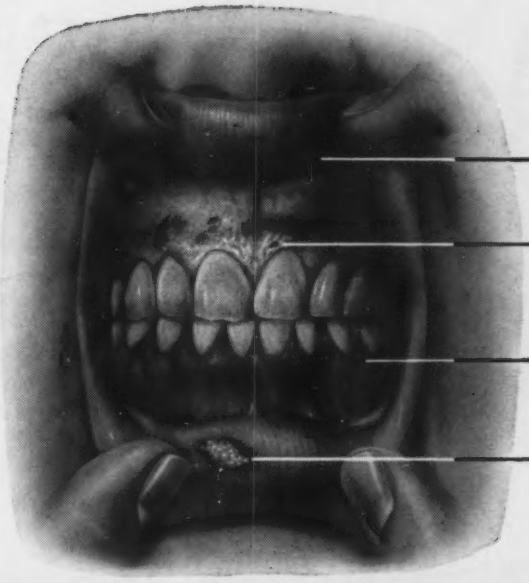

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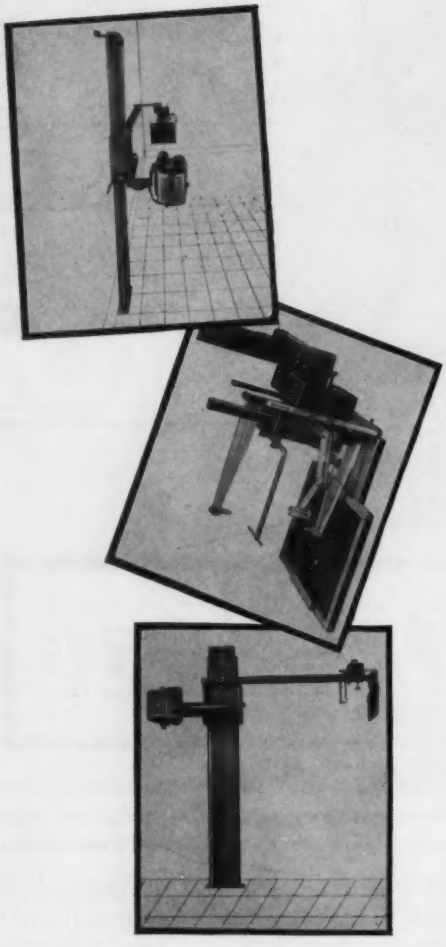

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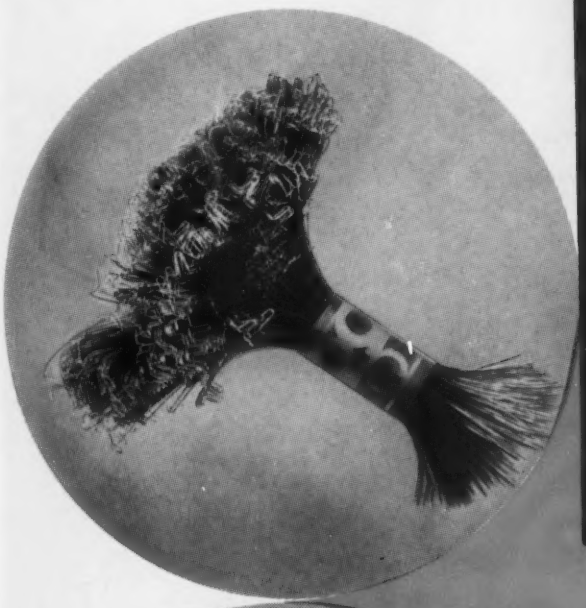

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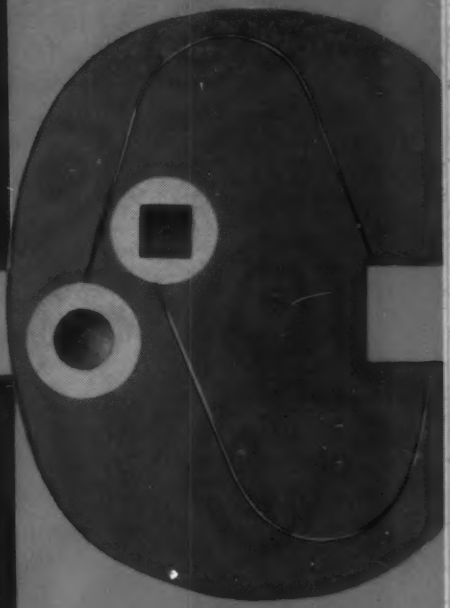

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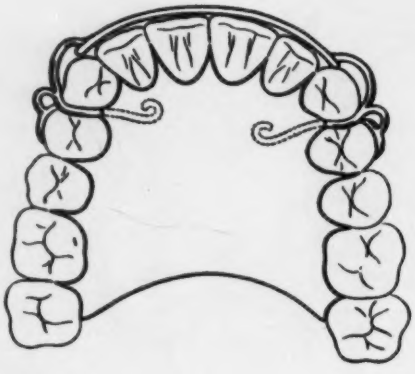

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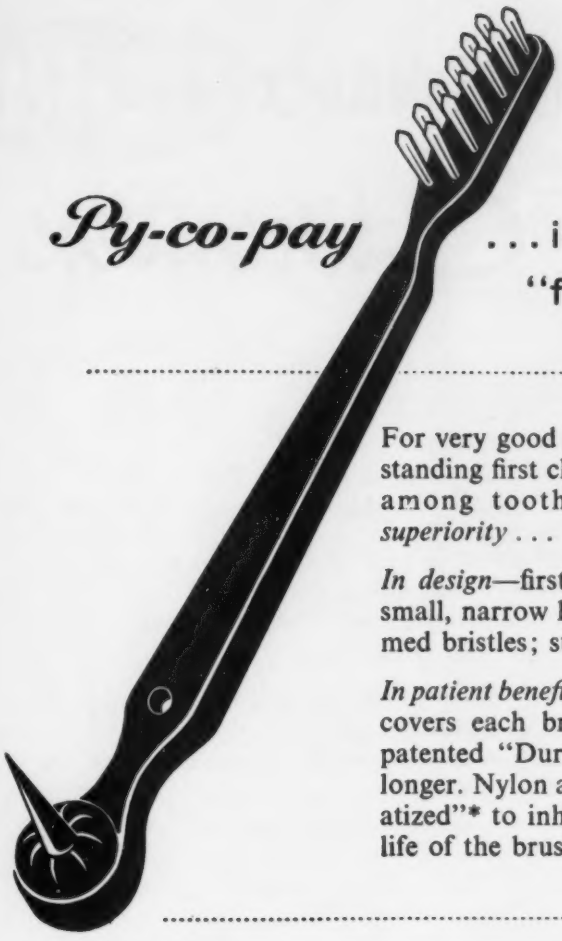

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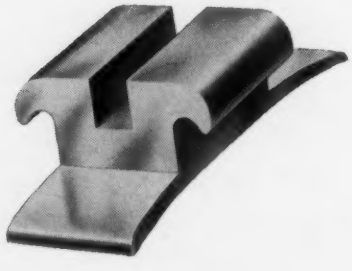

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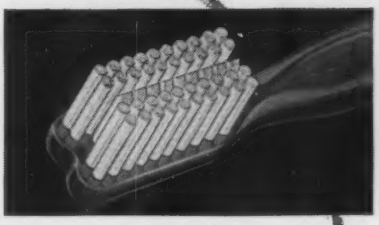

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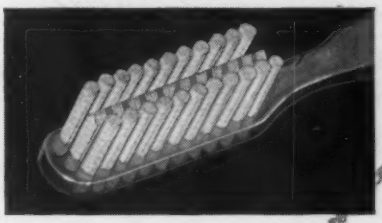

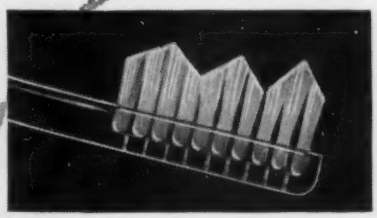

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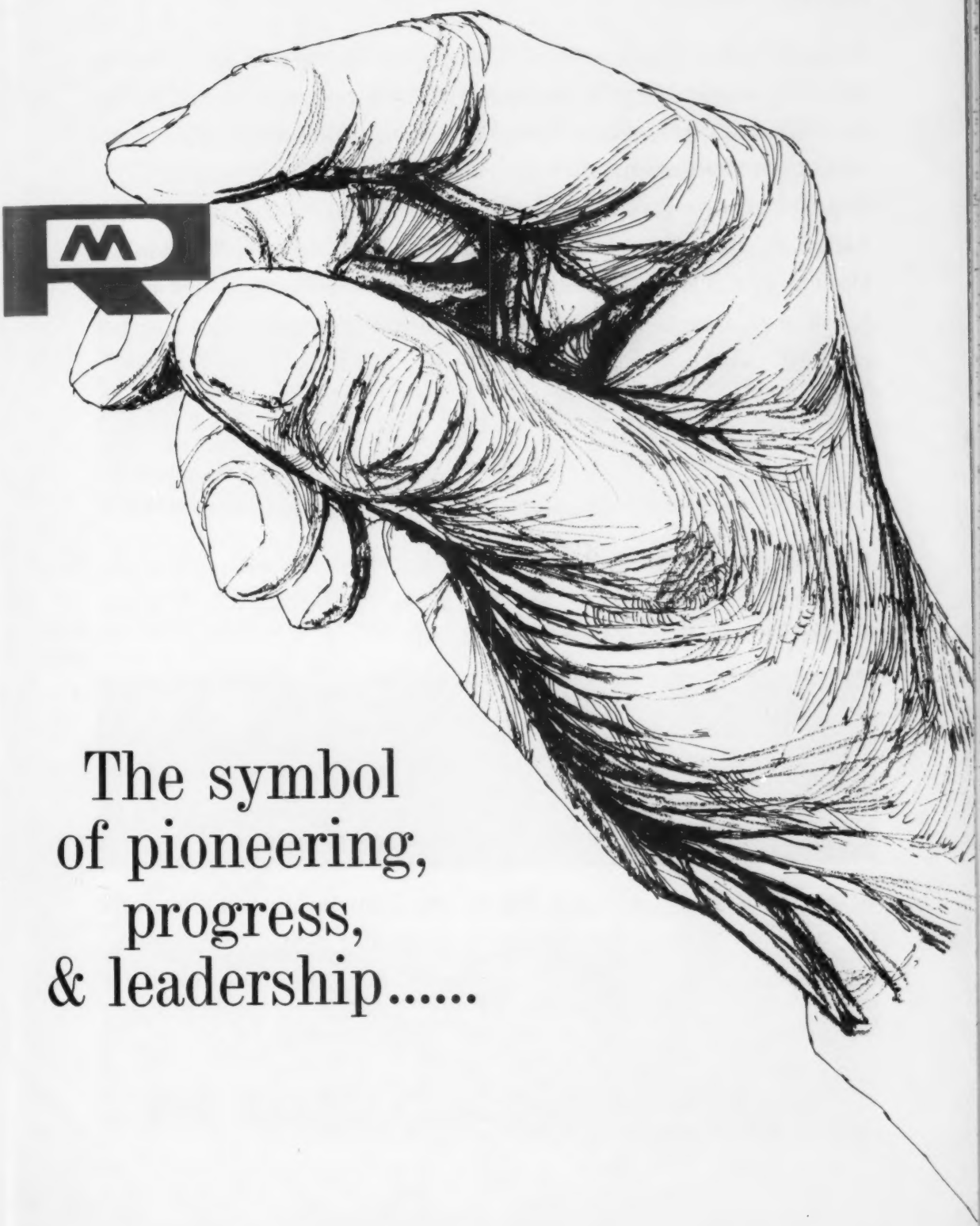

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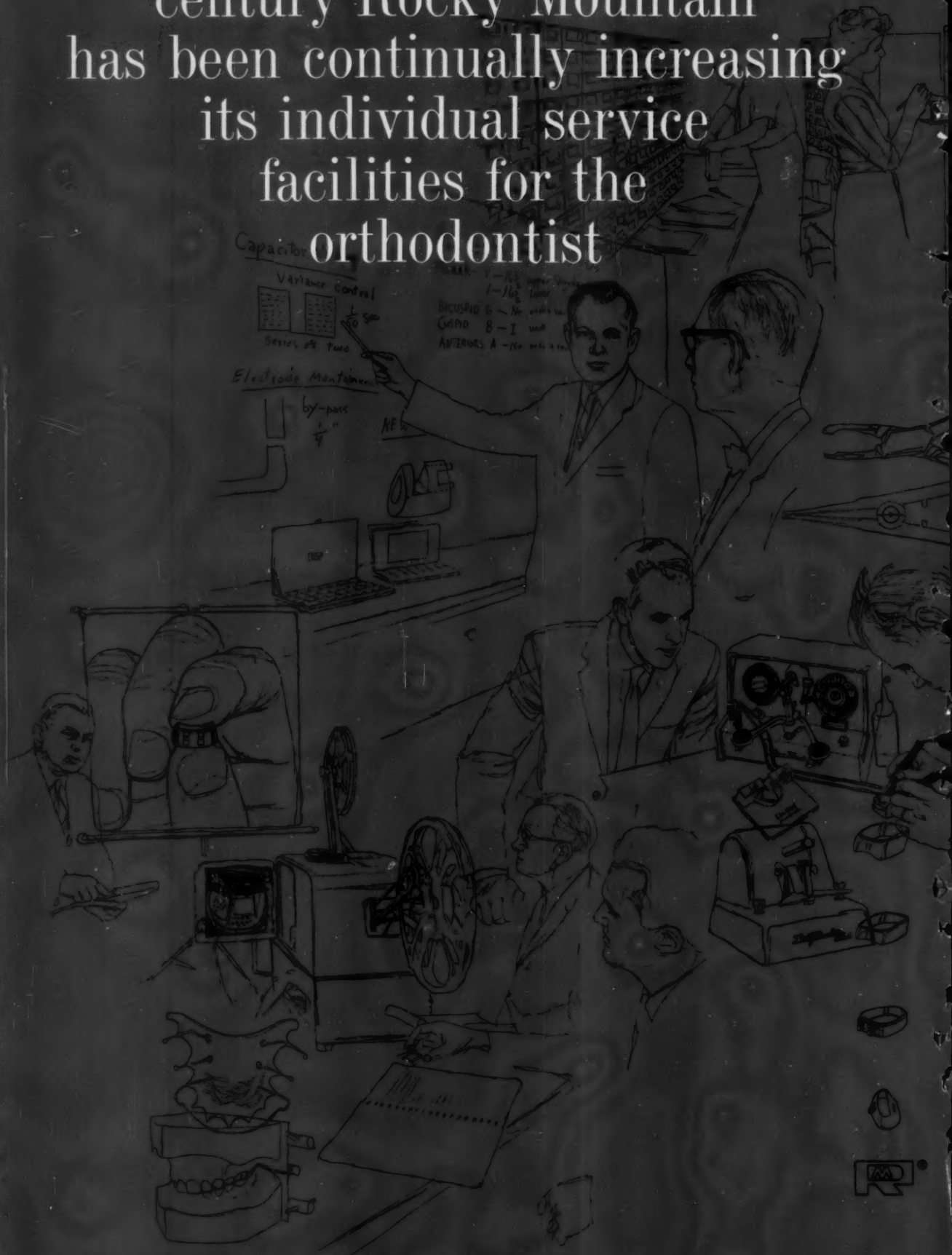

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American Journal of ORTHODONTICS

Volume 47, *Number* 9, SEPTEMBER, 1961

ORIGINAL ARTICLES

President's address, Great Lakes Society of Orthodontists

HUNTER I. MILLER, D.D.S., M.S.
Flint, Mich.

WELCOME to the Cincinnati meeting of the Great Lakes Society of Orthodontists. I know that most of you are in Cincinnati for this high point of the meeting—the reading of the president's address. However, I have news for you: there is more! We believe that we have planned a very stimulating program—scientifically, clinically, and socially.

I want to thank the Cincinnati area orthodontists and their wives who have worked so long and so diligently in the planning and preparation of this meeting. The men and women who have done all this have been duly credited in the official program, but I feel that this is modest recognition indeed for the time and effort involved. I know that I speak for all of them when I say it is their hope that you will enjoy the meeting they have arranged for you.

First, I would like to thank Dr. Herbert Frankel who has served as general chairman and spark plug of all the local arrangements. He has incubated, planned, and lived this affair for nearly three years. He has had moments of bitterness, none worse than when we were required to set three different dates for our meeting before we could finally pacify all segments of the membership. Each time, Herbert rearranged everything and went on to even greater heights of the planner's art. He has done a tremendous job for our society. Assisting him were a loyal cadre of Cincinnati area orthodontists and their wives.

I wish to thank Sam Ackerman, our hospitality chairman, and Mrs. Ackerman, chairman of the local Women's Committee. Incidentally, these ladies have gone all out to ensure our wives a pleasant stay in Cincinnati. Also to be thanked are the following committee workers: Dr. and Mrs. F. M. Deuschle, Dr. and Mrs. E. C. Hissett, Dr. and Mrs. W. R. Schmidt, Dr. and Mrs. L. J. Lowery, Dr. and Mrs. C. R. Duncan, Dr. and Mrs. T. B. Martin, Dr. and Mrs. E. Desatnik, Dr. and Mrs. D. S. Louie, Dr. and Mrs. M. Mayerson, Dr. and Mrs. W. W. Duvendeck, Dr. and Mrs. A. B. Lewis, Dr. and Mrs. H. G. Frankel, and Dr. and Mrs. S. P. Adams.

Presented before the Great Lakes Society of Orthodontists, Cincinnati, Ohio, Nov. 28, 1960.

I want to thank Robert Coleman for assembling a group of outstanding clinicians for our table clinics tonight. Our talented secretary, Ed Cheney, has gone far beyond the call of duty in the assistance he has given your president. Tom Crouch is to be thanked for our scientific program, and Floyd Arnold is acting as host to our visiting essayists.

It is customary in these closing hours of a presidential term for the retiring executive to point with pride to the accomplishments of the past, to view with alarm the crises of the present, and to offer modest recommendations for a better future.

I view with alarm the preceptorship problem. Orthodontics is a specialty whose business is to deal with malocclusion. It does not matter what causes the malocclusion or why it occurs; it is still the orthodontist's responsibility to understand and to correct (or to help correct) malocclusion. Toward this end the orthodontist is required to devote two years to specialized training, beyond his training for a dental degree, to develop a threefold ability:

1. To understand the basic phenomena which produce malocclusions.
2. To foster the individual background required for proper diagnostic and treatment procedures.
3. To create and use skills and techniques that are adequate to institute and control the required therapy.

In spite of the foregoing requirements, we are presently turning over, or permitting to be turned over, decisions about malocclusions to persons who do not have sufficient training to properly engage in practice.

Orthodontics as a specialty is growing up. As it passed through its early and respected infancy under Dr. Edward H. Angle, it achieved a substantial and good beginning. Dr. Angle insisted that the problems of malocclusion were quite different from the ordinary problems of dentistry and that, consequently, a person entering this field of dental practice should have special and advanced training beyond that given students of general dentistry. At that time the only access to this specialized training was made available by the few who had undertaken the individual study of orthodontics. These self-taught orthodontic specialists were versed in both knowledge and understanding of this subject well beyond the resources *then* made available at the universities. This fact in itself, *at that time,* made preceptorships not only desirable but necessary.

Gradually, however, the services and knowledge of these pioneers have been made available to the universities, where powerful and comprehensive teaching centers have been formed. Without developing this history, which you all know, or belaboring the point further, we must realize that we have come to a situation where preceptorships are dangerous—not only to the persons who undertake them but also to the welfare of the profession as a whole. No man has within himself either sufficient knowledge or sufficient resources to give proper professional training to a person who is going to have the right at the conclusion of that training to call himself an orthodontist.

I realize that the American Association of Orthodontists has set 1967 as the final date for inaugurating preceptorships, but a profession is shortsighted

indeed to continue an outmoded technique of training for another ten years, when all of us know that it would have been more sensible if we had discontinued preceptorships ten years ago and thus avoided the stigma of adolescence and immaturity.

Another disturbing situation facing orthodontists is the booming activity of the "two-week specialist" and the general practitioner coached or guided by the commercial laboratory. These people are now undertaking complex and difficult orthodontic treatment. They no longer limit themselves to mild preventive and corrective measures. They are casual and haphazard in their approach to orthodontic problems. Too often they not only misdiagnose cases, but they also treat cases in such a way that they seriously damage the welfare of the patient and the prestige of our specialty. Too often they have to be bailed out of their professional ineptitude by a properly trained person who is then forced to cover up activity bordering on malpractice. Serious problems of dental ethics arise in this connection.

Another issue which requires decision is the role of the pedodontist in orthodontic therapy. Here we all realize that the university-trained pedodontist rightfully and correctly is receiving some orthodontic training. The bitter bone of contention in many graduate dental schools today is the extent to which this added training in orthodontics should be given to students preparing to become specialists in the field of pedodontics. These students are demanding more and more orthodontics. Personally, I do not know where this training should stop. I do believe, however, that it should stop considerably short of orthodontic speciality status. It should be sufficient to enable the pedodontist to do sensible work in relatively simple cases, and it should be enough to augment his good foundation in child development and in long-term dental planning. Because the dividing line between the two specialities is not clear-cut and because this is a poorly defined area of overlapping training, it would be helpful and make for a better future in the dental profession as a whole, if we, the orthodontists, worked with and advised the universities in making decisions as to the correct amount of technical and academic training needed in each field in order to interlock these independent but interdependent specialities more powerfully.

Currently there is much turmoil and argument at the top level of the American Dental Association and the American Association of Orthodontists over the licensure of specialists. The Committee on Education of the American Dental Association has prepared proposals for approval by the House of Delegates at the Los Angeles meeting to require certification by a speciality board before a person could offer his services to the public as a specialist. This ruling was to apply to all specialities of dentistry. The A. D. A. was and is demanding that our American Board of Orthodontics certify a specialist *before* he begins practice.

The American Board of Orthodontics and the officers of the American Association of Orthodontists are insisting that this is not the role or the purpose of the A. B. O. They insist that the function of our Board is to examine men five years or more after they have been in exclusive practice and then to grant

them the status of a diplomate of the Board if they present evidence of definite achievement in the field of orthodontics. As a result of the opposition voiced by the specialties in Los Angeles, the A. D. A. committee agreed to table action on their demands for one year, but there was no evidence that the same demand would not be brought to the House of Delegates at the 1961 meeting.

Ten states have laws controlling the licensure of specialists on a legal basis. It would seem to behoove the voters, the specialists, and the dentists of the remaining forty states to take steps to secure similar legislation to protect dental as well as public interests. To force our American Board of Orthodontics to certify persons on a national basis before they begin practice would destroy the purpose of our Board.

If, as seems probable, the A. D. A. persists in its demands for certification by organized orthodontics in the states that do not have state licensure, then some form of certifying board should be established by the A. A. O. in each state to handle this certification at the local level and on a local basis and thus allow our American Board of Orthodontics to continue functioning in its traditional role.

Now I would like to bring to your attention my prize problem. It is the advancing socialization of the healing arts. Candidly, I think that we are past the stage of worrying about socialization—I know that we are moving into it. High school groups use it as a topic of debate. The new Administration assuming office in Washington in January is unequivocally committed to further socialization of medicine.

We are all familiar with the fact that there are medical and dental programs operating on the Pacific Coast on a panel basis. Most of these panels function with a salaried personnel working for industrial, union, or insurance groups. We have read with mild alarm what is happening to dentistry in the far western Canadian provinces of Saskatchewan and Alberta. Probably the alarm is mild because we are a little uncertain as to just where Saskatchewan and Alberta are, and we tend to assume that what is happening there cannot happen here. But, gentlemen, we are closer than you think.

Within the past few months the UAW-CIO in Michigan has announced the inauguration of its own medical program on a prepaid insurance basis. The group will employ a salaried medical panel and provide its own hospital facilities. In addition, plans call for offering this panel service to other groups outside of the UAW-CIO. The medical specialists are already employed, and this is right here in our Midwest. The Riggers Union in Detroit is currently employing a dentist on a closed-panel basis. The employment of panel dentist specialists cannot be far behind. Do not think for a moment that they will be unable to find dental personnel to staff these positions. Why will they find orthodontists among others? Because they pay high salaries!

I can go into orbit at this point and visualize a very dark future in which it is not unreasonable to expect to find orthodontic clinics being run on a mechanistic assembly-line basis rather than on a satisfactory professional basis. I can offer no easy solution to this socialization problem. I can, however, urge

that all of our dental groups give serious, judicious, and immediate opposition to what appears to be an unwise and dangerous trend. One serious and judicious suggestion that I would make to an orthodontic group would be that we conduct our practices in such a way as to avoid pricing ourselves out of the market—and out of business.

Now let me conclude on a happier note. Orthodontics has accomplished much in the past; we are doing well in the present; and if we keep ourselves a well-trained and competent specialty, alert to the problems and issues of the moment, we can provide effective opposition to further socialization rather than helplessly drifting into it.

I thank you, gentlemen.

Mott Foundation Bldg.

The effect of ionizing irradiation on the developing maxilla and mandible

JOHN J. BYRNE, D.D.S.
Chicago, Ill.

INTRODUCTION

THE RESULT of continual evaluation of the effects of ionizing radiation is that the decrease in the permissible dose has accompanied the acquisition of knowledge concerning the hazards associated with this form of energy. In 1935 the magnitude of 0.1 r per day was established; in 1946 it was reduced to 0.3 r per week. Only ten years later 5 r per year, or 0.096 r per week, was the acceptable level of total-body irradiation. Currently the emphasis is placed on restricting the total dose that may be accumulated during the reproductive period (to age 30) to 50 rem. This is to control, if possible, the normal spontaneous mutation rate, for estimates of the dose necessary to double the rate of mutation formation range from 3 to 150 r.

A statistical survey of radiologists by Macht and Lawrence[1] indicated a small but significant difference in abnormalities occurring in the first generation when a parent received light prolonged doses of ionizing radiation. The pertinent anomalies reported were clefts of the lip or palate, or both, and missing teeth. Genetic factors are not a primary concern of this article, however; nor is the rise in background radiation, except when the contributing factors may be metabolized by the individual and become a permanent constituent of a tissue or organ. Our area of interest is the more immediate effect of ionizing radiation on growing bone. Ionizing radiation is commonly used on bone for diagnostic purposes in dentistry and in the specialty of orthodontics. The routine cephalometric roentgenogram contributes greatly to our analysis and understanding of growth in the head and face. Consequently, certain areas are examined frequently when disturbances of structure or function are evident. The capabilities of x-radiation to produce serious damage in bone are well known. The effect on

This thesis, which was given as a partial fulfillment of the requirements for certification by the American Board of Orthodontics, is being published with the consent and the recommendation of the Board, but it should be understood that it does not necessarily represent or express the opinion of the Board.

growth centers in the maxilla and mandible, with subsequent development of deformities has rarely been reported and is poorly understood, as is the mechanism by which the x-ray influences the physiologic activity of the cell. In this article I will attempt to evaluate some aspects of this action.

REVIEW OF THE LITERATURE

It has been known for many years that, experimentally, x-ray irradiation was capable of inhibiting growth in bone.[2] Besgard and Hunt[3] showed the retardation to be influenced by the growth rate of the region exposed. The areas most accurately studied in man have been the long bones, spine, and ribs. Langenskiold[4] presented a classic report of a delayed growth disturbance evident ten years after irradiation of the femur and tibia during prolonged fluoroscopic examination.

Stevens[5] described an interesting case in which a 4-month-old infant had an extensive nevocarcinoma of the skin. The upper two-thirds of the femur and lower quadrant of the vulva were irradiated. At 122 r per dose, 976 r was given in eleven days. Two months later 840 r was given in eighteen days. Shortening was evident at 15 months, and the leg was 2 inches shorter at 4 years. However, the child did walk at 18 months. The x-ray exposure factors were as follows: 200 kv., 1 mm. copper, 1 mm. aluminum, 30 Ma. at 50 cm.

Bloom[6] observed several effects on spine. A tissue dose of less than 1,000 r produced no defects, regardless of age. At 1,000 r to 2,000 r, changes were minor if the child was over 2 years old. However, exposure above 2,000 r in children under 2 years caused definite growth disturbances. There were changes in the epiphysial plate and horizontal lines of delayed growth. Beyond 5,000 r injury was permanent, although function might be preserved. The characteristics of the irradiation were not specified.

Neuhauser and associates[7] found no demonstrable damage to the spine at 1,000 r, regardless of age. However, 2,000 r caused injury, regardless of age. In patients over 2 years of age, 1,000 r to 2,000 r produced only minimum disturbance. He found that epiphysial growth was retarded at 600 r, but there was no detectable stunting at 500 r. A single exposure of 1,200 r produced complete epiphysial arrest.

In the immature bone there was devitalization of osseous structure, resulting in demineralization, avascularity, and subsequent fractures. Catabolic processes were more readily affected, and there appeared to be greater damage to osteoclasts.

Krabbenhoft[8] found demineralization to be essentially permanent at 3,500 r to 4,500 r. Severe damage or death occurred at 5,000 r to 8,000 r, and benign lesions so irradiated occasionally became malignant after ten to fifteen years.

There have been numerous reports concerning the effect of ionizing radiation on the developing dental system.[9] Unfortunately, the dosages involved are rarely known.

Wildermuth and Cantril[10] conducted an extensive survey of radiation necrosis of the mandible. Gowgiel,[11] in an excellent experimental study of the *Macacus rhesus* monkey, demonstrated the dosage at which necrosis occurred,

its initial location, and the mechanism of the reaction in the critical area. He also reported that root development was destroyed at 4,500 r to 5,000 r. Teeth usually erupted and were retained by the gingiva at the stage of development that was present when irradiation occurred. Occasionally some teeth were ankylosed and underwent resorption.

The first exposure of a population group to intense irradiation occurred in the atomic bomb explosions at Hiroshima and Nagasaki in Japan. The Atomic Bomb Casualty Commission has supported extensive and continuous observations to determine the effects of ionizing radiation from atomic bomb explosions on the offspring of women who were pregnant or of child-bearing age and living in the affected cities. Another subject of critical investigation has been the effect of radiation on children of these regions.

Sutow and West[12] reported anomalies of the ribs, spines, and hands of children exposed in utero to the effects of the atomic bomb. Of 1,771 female survivors from within 2,000 meters of hypocenter, 99 were pregnant. Of the 75 children born, 74 were alive in 1952. At 4,000 meters to 5,000 meters, 113 of 1,744 women survivors were pregnant. From this group 98 children were alive in 1952, and 91 were available for examination. These children would have been approximately 7 years old at that time. No abnormalities of facial bones were reported in either group from Nagasaki.

Greulich, Crismon, and Turner,[13] in a 1950 physical growth and development survey of both Nagasaki and Hiroshima children, showed that height, weight, and skeletal development were retarded five and one-half years after the bombing. Boys showed significantly more retardation than girls. The effects of thermal irradiation may have contributed to some of these groups. Renolds[16] observed that the children within 1,500 meters of hypocenter who experienced severe radiation symptoms tended to lag considerably behind those who did not have these complaints. However, cranial or facial anomalies were not evident.

Microcephaly, both with and without mental retardation, was reported in children exposed in utero to atomic bomb radiation. The diagnosis of microcephaly was based upon measurments two or more standard deviations below those of control Japanese children of comparable age and sex. Both Plummer[14] and Sutow[15] surveyed this aspect. Twelve of the Hiroshima children were microcephalic, and ten of these were mentally retarded. The two microcephalic children of the Nagasaki group were also mentally retarded. These reports were the first indication that irradiation had affected a developing fetus, altering its cranial growth.

Discussing the delayed effects within the first decade from exposure of young children in Hiroshima, Miller[17] analyzed the critical distance for exposure and the critical periods of gestational age during which head growth might be influenced. Within 1,800 meters, unless shielded, victims received ionizing radiation of consequence. Beyond this distance, however, the drop-off was rapid and the amounts unimportant from the standpoint of immediate effect. Microcephalic children with head circumference more than three standard deviations below normal were between the gestational ages 7 and 15 weeks when irradiation occurred. At 7 to 15 weeks all eight children at 1,200 meters were affected as were

four of twenty-two children at 1,200 to 1,500 meters and four of sixteen children at 1,500 to 1,800 meters. At 16 to 25 weeks two of twenty-three microcephalic children were in the 1,200 to 1,500 meter range. In the 1,200 to 1,500 meter radius, the two children who developed mongolism were between the gestational ages of 7 and 15 weeks. From this we may conclude that the fetus up to 25 weeks of age might be affected if it was within the 1,800 meter zone. The amount of ionizing irradiation received by the mothers of these children is difficult to assay. However, nine of fifteen suffered epilation, and six had purpura. Similar cases of microcephaly were shown by Murphy[18] to have resulted when women in the first half of pregnancy were accidentally overexposed to irradiation for the treatment of disease in the pelvic area.

Ohata[19] detected no significant difference between exposed and nonexposed children with respect to the development of molars at 6, 12, and 13 years. Development of the head was similar in both groups. Tirasaki and Shiota[20] found hypoplasia more common in exposed groups and caries more evident, especially in deciduous teeth. There was no difference, however, in root formation or eruption time.

Localized oral lesions three to six weeks after the explosion were reported by DeCoursey.[21] Acutely ill persons presented ulceration and hemorrhage of the mucous membrane resembling adult noma. These patients died. Symptoms of the less severely injured were those of aplastic anemia or leukemia. Because of the fatal nature of this irradiation, the victims did not survive long enough to exhibit growth deviations or even osteonecrosis. Consequently, these cases cannot serve as an indication of the amount of radiation in the area. This, however, would be about 400 to 600 r.

The reports just cited indicate the extensive nature of investigations concerned with the effect of ionizing radiation on growing bone. However, virtually all of these investigations are characterized by a common deficiency. The specific quantity of ionizing radiation responsible for alteration of the pattern of development was unknown or the range of dosage was quite variable.

In our area of special interest, the face and jaws, there is a paucity of reports of cases in which x-ray radiation or radium has altered or terminated growth. Ordinarily, the experience with irradiation occurred at an early age and was reported several years later by another person. Detailed information of the therapeutic procedure was rarely available. The four case reports that follow, revealed by a search of the literature, involved injury to the face or jaws.

CASE 1. Dechaume and Chauepe[22] reported a case in which unilateral roentgenotherapeutic atrophy of the ramus followed radiation treatment.

History. The patient was a 19-year-old boy with an asymmetrical face which was flattened in the masseteric region. The patient's history revealed that a few weeks after his birth an angioma had appeared in the right masseteric region. This was first irradiated when the patient was 5 months of age; six doses of 300 r each were given. Five years later the area was irradiated again for treatment of a submaxillary adenitis following an incision; at that time four doses of 300 r each were given. Thus, a total of 3,000 r was received by this region before the patient was 6 years of age.

The deformity began when the boy was 12 years old, and it progressed.*

Findings.

Length of body: Go-Gn was the same on both sides, within 1 to 2 mm.

Ramus height: The linear measurement of gonion to glenion was 3.5 cm. This is 2 cm. less than on the left side.*

Maxillary arch: Clinically, the right second premolar was missing. Intraoral roentgenograms confirmed the absence of both the right second premolar and the third molar.

Mandibular arch: The right second deciduous molar was retained, and the second permanent molar was missing. Roentgenograms indicated the absence of the second premolar and the second and third permanent molars. The roots of the first permanent molar were destroyed, but the crowns were normal.

Arch form: Occlusion was excellent and arch form was regular.

Occlusal plane: The curve of Spee was upward and to the right.

Mandibular angle: The mandibular angle was 140 degrees on the right side and 120 degrees on the left.

CASE 2. In 1947 Kisfaludy[23] reported a case in which underdevelopment of the mandible occurred as a side effect of irradiation therapy.

History. On June 7, 1936, a 10-year-old boy was given irradiation treatment for a tumor (lymphoepithelioma). On four consecutive days 120 mgh moulage was applied to the tumor and 120 mgh of radium to each side of the base of the tongue. This relieved the symptoms. X-ray therapy was then instituted. Nineteen doses of 100 to 150 r each were directed to both sides of the mandible in the submandibular field, making a total of 2,500 r. The tumor atrophied to a hard, pea-sized mass and was electrocoagulated. In January and November of 1937, and in February of 1938, radium treatment to the right side of the base of the tongue was given on three consecutive days with 100 mgh of radium.

Findings. In 1939, three years after therapy was begun, cessation of growth was perceptible. Examination on May 22, 1947, showed atrophy of the right half of the tongue. There was hypertrophy of the left side, with deviation to the left.

The maxillary denture was complete, but in the mandible three teeth were missing.

The mandible was small but symmetrical. The underdevelopment extended evenly to the body and ramus. The mandibular anterior area was 0.5 cm. "behind the upper." Molar occlusion was possible because of "outward, upward" positioning of the teeth (probably occlusal elongation with mesial crown inclination).

Kisfaludy believed that the mandibular asymmetry was due to x-ray irradiation. If it were due to the radium one side would have been affected more than the other, as was seen on the tongue.

CASE 3. In 1955 Murai[24] reported a case of radiation injury to the teeth and jaws.

History. The patient was a 12-year-old girl who was born with a hemangioma of the entire mandible. For seven days after birth the patient received short-distance irradiation after the method of Chaoul. Irradiation was confined to the affected area. For six months it was administered once each week for a period of three to five minutes. Following this course of treatment, the region was irradiated once each month for three years.

*Alteration of growth probably occurred before the second year. The altered ramus was 3.5 cm. in height; the normal ramus, 5.5 cm. This indicates that the altered ramus had attained about 63 per cent of the normal height for the individual. Normally, the mandible is shown to be 68 per cent complete at 2 years. Cessation of growth probably occurred before the patient was 2 years old. (The period of irradiation was not mentioned. It may have lasted to 1-plus years. The width of the ramus was not given.)

Findings. There were no particular anomalies in the deciduous dental arches or teeth, and function was normal. On examination of the area, Murai found telangiectatic capillaries and atrophic skin with some depigmentation. Although the oral mucous membrane and lips were normal, there was marked underdevelopment of the jaws and the dentition was abnormal. The dentition was as follows:

$$\frac{6\ 5\ 3\ 1\ |\ 1\ 2\ 3\ IV\ 6}{6\ c\ b\ |\ \ c\ \ 6}$$

The crowns were small, and the roots were thin. The maxillary teeth, which were a greater distance from the source of irradiation, were less severely affected.

CASE 4. Ohta[25] reported the Atomic Bomb Casualty Commission's Hiroshima investigation of 1,309 children (659 exposed and 650 nonexposed). The children, who were 8, 10, 12, 14, 16, and 18 years of age, had been exposed between the ages of less than 1 year and 10 years. Of twenty-two measurements taken, three showed that statistically significant differences existed between exposed and control children: tragion-tragion, zygion-zygion, A-N-pogonion and B-N-pogonion.

The findings in the exposed group indicate a narrow facial width and protrusion of the mandibular alveolar base. Mentum was advanced. There was no difference between the lengths of the eye-ear plane or the orbitale-gnathion measurement. Consequently, vertical development and upper face appeared normal, the region of the jaws being constricted and protrusive.

THE EFFECT OF IONIZING IRRADIATION ON THE DEVELOPING MAXILLA AND MANDIBLE

I encountered the following case while I was serving as an orthodontist in a United States Army Hospital.

A 21-year-old soldier presented for routine dental examination. The consulting dental officer, noting the severity of the patient's malocclusion, referred him for orthodontic evaluation.

History. The patient stated that his parents had informed him that he had a "birth mark in front of [his] ear, but it left after the doctor x-rayed it." He recalled the x-ray treatment but no additional visits to the physician following it.

The physician who administered the x-ray therapy was located, and he submitted the following report:

> In July, 1936, the patient received x-ray irradiation for a hemangioma of the right malar area. He was given 2,000 r (this was on the skin) over the right malar area at 200 KVP, 8 Ma., and thoreus filter (2 mm. copper), 50 cm. distance. This was given between July 31, 1936, and Aug. 5, 1936. The patient was seen several times for examination, and continued improvement was noted. Between June 2 and June 7, 1937, he was given 1,500 r (on the skin) at 200 KVP, 19 Ma., 50 cm. distance. The field was a 6 by 6 cm. area over the right cheek. The patient was 5 years old when treatment was initiated. He was not seen after June, 1937.

Findings. The patient exhibited a flattened right zygomatic area. The skin from the tragus to the inferior border of the orbit was pale in color, with patchy pigmentation. A telangiectatic area about 2 cm. in diameter was evident; the patient was wearing face powder to alter the color. The right malar bone appeared to be about 2 cm. distal to the left one. There was moderate scarring of the right ala, with the nasal septum deviating to the right. On frontal examination, the left side of the face was seen to be longer and larger than the right. This caused the face to appear as though the left side were growing toward the right.

On intraoral examination, the tongue and mucous membrane of the buccal area and lips were found to be normal. In the right maxillary canine region a small discrete area of osseous hypertrophy was covered by a thin layer of mucous membrane. On the right side the maxillary canine and the mandibular second molar were clinically missing.

Study models revealed that the maxillary arch had relatively good symmetry. Teeth on the left side were about 3 mm. mesial to those on the right side. The distance of the six-year molar from the palatine suture was 23 mm. on the left and 20 mm. on the right. The left side of the palate was flatter than the right. The right canine was clinically absent. The mandibular arch was asymmetrical. Teeth on the right side were about 4 mm. mesial to those on the left. The arch was flattened from the left central incisor to the right first premolar. The second permanent molar was missing.

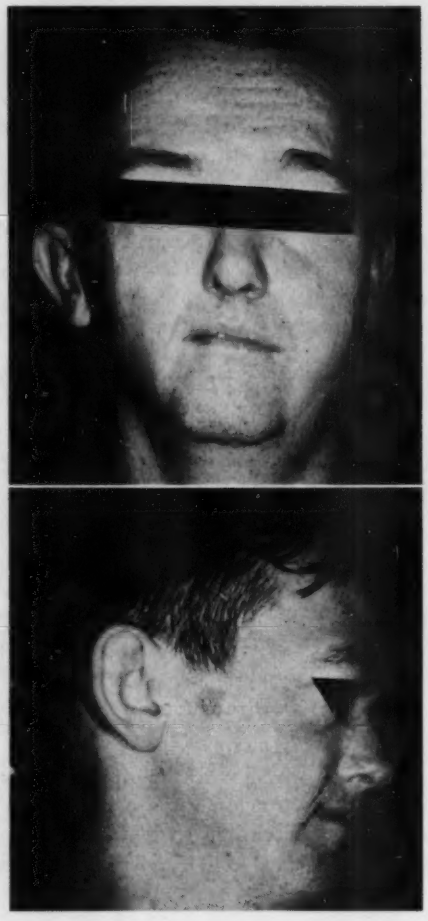


Fig. 1. Frontal and profile views.

Occlusion was limited to three teeth on the right side—the premolars and the first molar. The left side was in cross-bite from the first premolar through the second molar area. An overbite of 6 mm. extended from the right lateral incisor area through the left second molar area.

Intraoral x-ray films revealed that all teeth on the left side were present, with the exception of the maxillary third molar. Root and crown development was normal for the mandibular left side. In the maxillary arch, however, root formation of the left lateral incisor, canine, and premolars was restricted. The apical halves of these roots were narrow and pointed. On the mandibular right side the first permanent molar roots were somewhat shorter than those on the left. The premolars had a narrowed root formation. The second permanent molar was missing. In the right maxillary area, the roots of the central incisor

and first molar were shortened. The root of the lateral incisor was about one-half the normal length. Roots of the canine, premolars, and second molar were missing. The canine was still embedded in bone.

Tracings of the cephalometric headplates demonstrated no great variation between the right and left sides. Measurements indicated that the right side was slightly retarded as compared to development on the left side. This was evident when the x-ray films were superimposed. Many of the cephalometric measurements are made from the midsagittal plane.

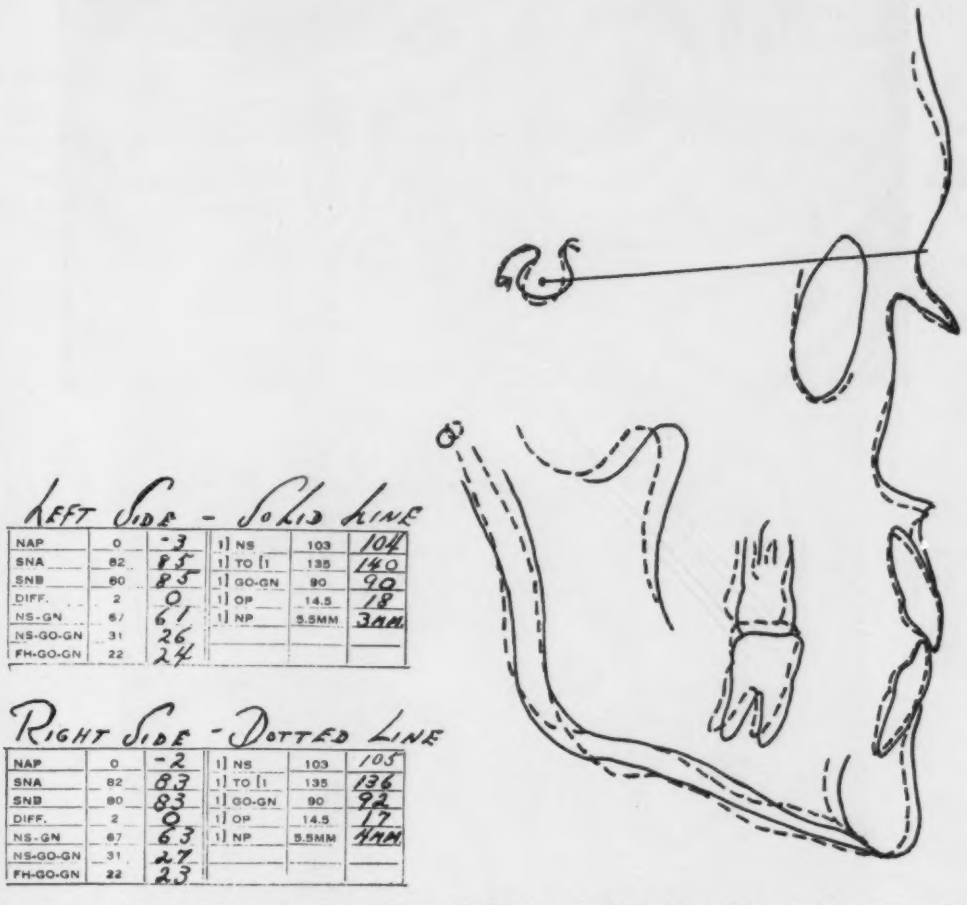

LEFT SIDE - SOLID LINE
NAP 0 -3 1] NS 103 104
SNA 82 85 1] TO [1 135 140
SNB 80 85 1] GO-GN 90 90
DIFF. 2 0 1] OP 14.5 18
NS-GN 67 61 1] NP 5.5MM 3MM
NS-GO-GN 31 26
FH-GO-GN 22 24
RIGHT SIDE - DOTTED LINE
NAP 0 -2 1] NS 103 105
SNA 82 83 1] TO [1 135 136
SNB 80 83 1] GO-GN 90 92
DIFF. 2 0 1] OP 14.5 17
NS-GN 67 63 1] NP 5.5MM 4MM
NS-GO-GN 31 27
FH-GO-GN 22 23

Fig. 2. Tracings showing growth of left (solid line) and right (dotted line) sides of the face.

Consequently, they do not indicate the extent of alteration that appears on clinical examination. Because growth of both the maxilla and the mandible was relatively advanced when irradiation therapy began, we do not see the degree of damage that would have occurred at an earlier age. However, the state of root development on the left side was a fair criterion of penetration. Added evidence of the effect of the irradiation was a pathologist's report on an exostosis removed from the right maxillary canine area. This report stated that the specimen was sclerotic bone.

Full-face and profile photographs of the patient (Fig. 1) show the clinical appearance of the area involved.

Fig. 2 shows the superimposed cephalometric tracings of the left and right sides of the face. The left side is represented by a solid line and the right side by a dotted line.

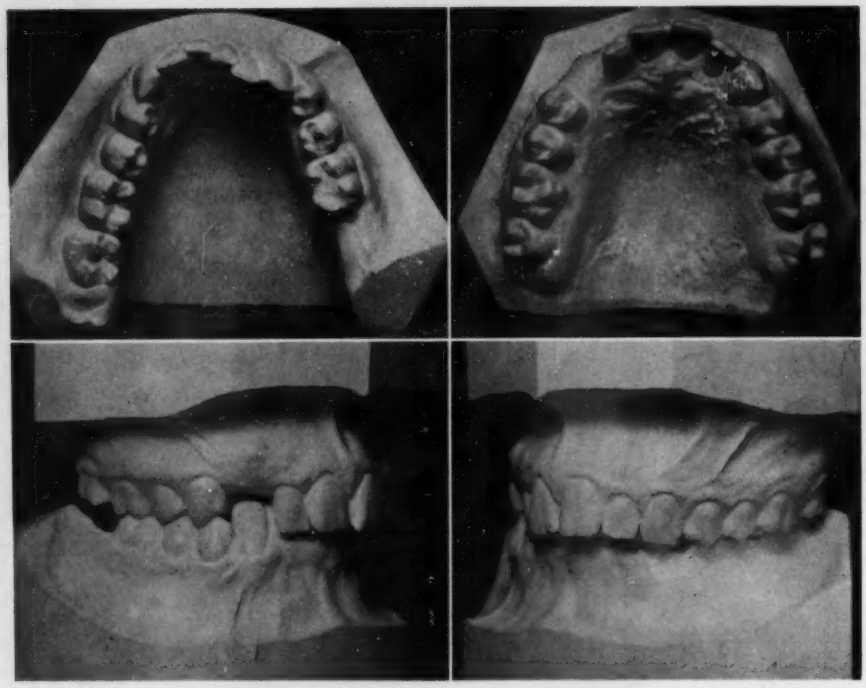


Fig. 3. Arch form and occlusion of the denture.

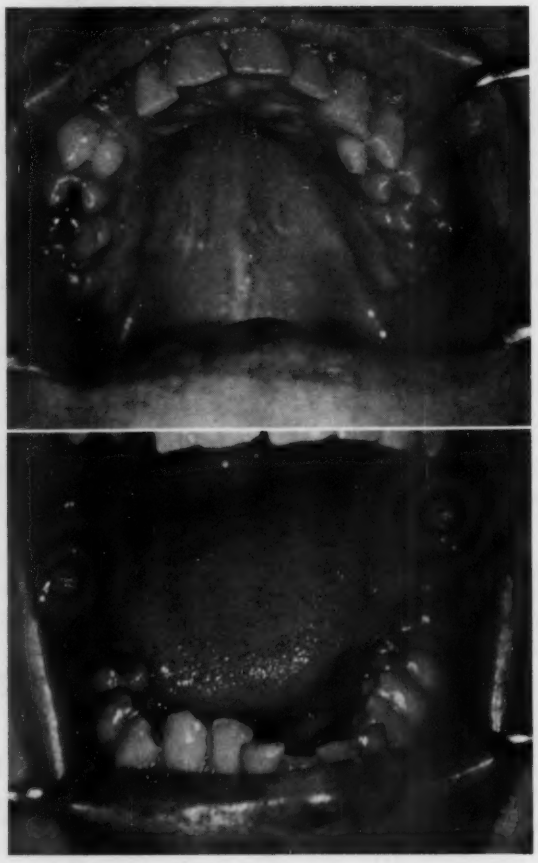


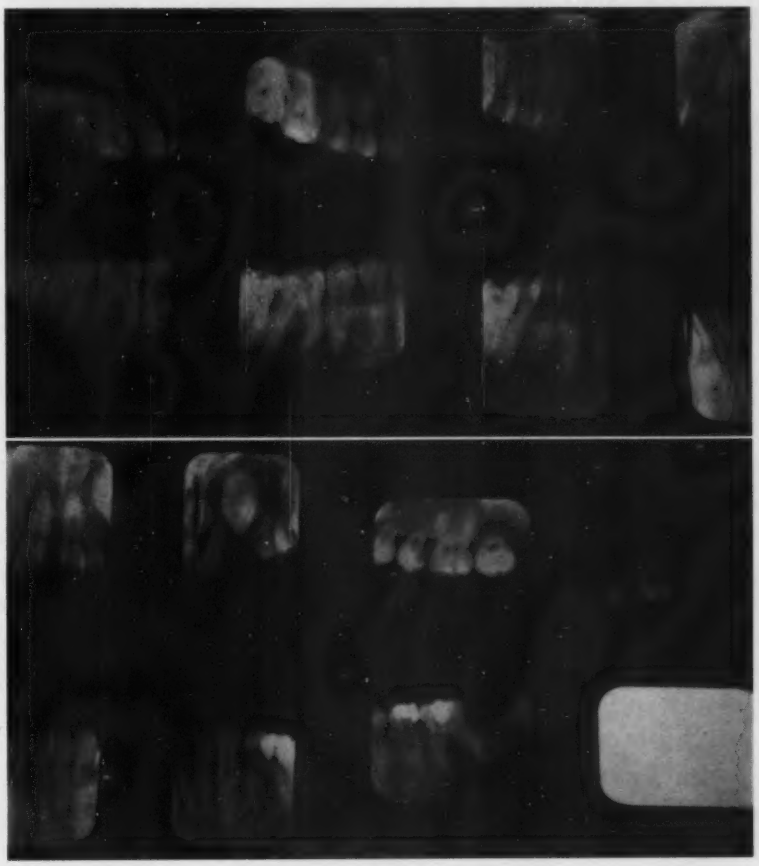
Fig. 4. Intraoral views showing normal soft tissue.

Fig. 5. Teeth are in occlusion. Exostosis is visible in maxillary right canine area.

The photographs in Fig. 3 show the malocclusion as it appeared in the patient's models. The condition is better observed here than in the intraoral views shown in Figs. 4 and 5. The latter, however, demonstrate the condition of the soft tissues.

The intraoral roentgenograms (Fig. 6) demonstrate the effects of irradiation on root development.

A.



B.

Fig. 6. Intraoral roentgenograms indicating altered root formation or cessation of root development. *A*, Left side. *B*, Right side.

GENERATION OF X-RAY IRRADIATION AND ITS CHARACTERISTICS

The preceding reports present clinical examples of the effect of ionizing radiation on bone. From these, it is evident that a given effect may be produced by several varying quantities of radiation. Apparently, quality of the beam is a factor of prime importance. To understand this better, it is expedient to know the mechanism of x-ray production and how it reacts in bone. Briefly, the x-ray is produced within the roentgen tube as follows:

The electrons at the heated cathode or filament have an electrostatic force exerted on them by the anode. As the electron accelerates across the evacuated tube, its kinetic energy increases until it strikes the anode. At this time its potential energy is zero and its kinetic energy is, in electron volts (ev.) the potential through which it has passed. An electron suddenly decelerated by striking the anode produces a changing electric current and consequently an electromagnetic field. The quantum of the electromagnetic energy depends on the kinetic energy of the electron or the voltage. High energy produces maximum frequency and minimum wave length.

In addition to this continuous x-ray spectrum, x-ray quanta of discrete energy are emitted which are characteristic of the anode target material. These are created when a high-energy electron collides with an electron in one of the inner orbits of a target atom. When this collision occurs with an innermost or K-shell electron, ejecting it from orbit, the deficiency in the K-shell will not persist, and an electron will drop from a higher-energy outer orbit into the lower-energy inner orbit. The difference in energy between the two orbits will be emitted as the electromagnetic energy known as x-ray. For a given material there may be a number of possible x-ray quanta, depending upon the difference in energy content of electrons in two of the target material's orbital shells.

Numerous indices exist for evaluating a material's ability to absorb x-rays. Essentially, they depend upon the mass of the material and its thickness. The phenomenon of absorption is controlled by one of the following mechanisms: photoelectric effect, Compton scatter, or pair production.

The photoelectric effect is the chief method of absorption for quanta of less than 100 kv. A quantum of electromagnetic energy encounters an electron, transferring all its energy to it and permitting it to escape the nuclear influence and become a photoelectron. Since less than 500 ev. is needed to dislodge the electron, the remaining energy gives velocity to the photoelectron. The photoelectron thus may ionize many other electrons before attaining thermal velocity and joining an atom. The major portion of ionization results from this secondary back scatter, with only a minor amount from original electromagnetic energy. Photoelectric absorption is greatest with low-energy, long wave length, "soft" radiation and occurs in the first few millimeters of tissue.

Compton scatter is a mechanism whereby high-energy quanta lose only part of their energy to an electron and continue as electromagnetic energy of longer wave length. The recoil quanta energy is the difference between the energy of the incident electron and the kinetic energy of the ejected electron. The energy of the recoil quanta may drop into the visible spectrum.

Quanta with energies greater than 1 million electron volts are often encountered in gamma radiation from the nucleus and can be converted into two particles, each having the same mass.

One particle (the electron) has a negative charge; the other (the positron) has a positive charge. This process is known as pair production.

Table I shows a gross division of the x-ray spectra and their general use and characteristics.

Table I. *X-ray spectra and uses*

Maximum energy (kv.)	*Approximate wave length (Å.)*	*Use*	*50% depth in tissue*
Up to 25	2.0	Superficial therapy	5 mm.
25 to 125	0.5	Diagnosis	5 cm.
125 to 200	0.1	Deep therapy	10 cm.
200 to 2,000	0.05	Supervoltage therapy	—

ACTION OF X-RAY IRRADIATION IN BONE

Stenstrom and Marvin[26] used bone chambers encasing an r-meter to study ionization within bone and to determine the level at which maximum damage occurred. They found that photoelectron production occurred in the wall of the chamber. It increased for long wave length irradiation as the atomic number of the elements in the wall increased. Short wave-length radiation affected photoelectron production only slightly. (At 200 kv. the path for secondary electrons is short, about 0.1 mm.) Maximum damage occurred in bone at 140 kv. and HVL 0.35 mm. copper. It decreased with higher voltage and greater filtration.

The manner in which interposed bone effects high-energy electron beams was reported by Haas and Sandberg.[27] As the x-ray penetrated the surface of the bone, a build-up layer of secondary radiation occurred. In compressed bone, 1 cm. thick, this layer shortened penetration of the primary beam by 6 mm. This back scatter of low-energy radiation may explain some of the soft tissue reactions caused by interposed bone.

Spiers[28] detailed the wave length of radiation produced at varying KVP and the amount of ionization which it caused in both soft tissue and bone. The range ordinarily used for dental or cephalometric roentgenograms is 80 to 100 KVP. This produces radiation of 0.35 to 0.25 Å. In soft tissue located within bone, the amount of ionization resulting from these wave lengths will be about two and one-half times greater than in soft tissue remote from bone. Consequently, the amount of radiation which can be tolerated by bone from medium-voltage x-rays is about one-third that tolerated by soft tissue. At this KVP the range of electron travel is 50 to 100 microns, a distance greater than the size of the soft tissue structures within bone.

An analysis by Quastler[29] of radiation action on the proliferative cycle disclosed disturbances of a high order which were characterized by a disruption of normal coordination in the routine functions of a cell, rather than an absolute disturbance of function or destruction of the cell. Apparently, there are two

critical phases in which this may occur. One is the mitotic phase, and the other is the S-phase during which chromosomal material, especially desoxyribose nucleic acid (DNA) is synthesized.

X-ray irradiation has several effects on DNA synthesis. It may delay the commencement of the S-phase, inhibit DNA synthesis in progress, or delay the termination of the S-phase. Thus, difference in quality or quantity may occur. The results of these phenomena are multiple. Incomplete synthesis of DNA causes incomplete doubling, yielding a sterile cell. Irradiation blockage in the premitotic period causes reversion to the presynthetic phase. The cell then re-enters the S-phase, again doubling the chromosomal material. Following mitosis these cells have twice the normal chromosomal material and are abnormally large in size.

Irradiation in the mitotic stage may cause mitosis to occur prior to chromosomal doubling. This produces precocious and incomplete maturation and may account for the small pyknotic cell.

SUMMARY

The mechanism of the medium-voltage x-ray effect on bone is apparently as follows: On contacting bone, much of the primary beam is converted to photoelectrons which are especially concentrated in the first 5 mm. of bone. The range of these electrons is short, about 50 to 100 microns. This does not permit extensive travel in calcified bone. However, the lacunae containing osteocytes are about 25 to 50 microns long, 6 to 14 microns wide, and 4 to 9 microns thick. Consequently, the photoelectrons easily traverse this distance, rebounding off the walls of the lacuna and ionizing the cellular elements within. Likewise, irradiation developing on the inner wall of a Haversian canal may readily cross its 22 to 110 microns, affecting the vessels and tissue within. Larger areas, such as the marrow cavity, are not greatly affected by short-range "scatter" from the wall.

Since the osteocyte does not undergo mitosis, death of the cell with evacuation of the lacuna is the usual effect of its ionization. Devitalized bone must be resorbed and replaced by living tissue. These processes are ordinarily accomplished by (1) the cellular elements from the periosteum, either on the external surface of the bone or within the Haversian canals, or (2) by the endosteum.

It was previously believed that irradiation had its initial effect on the blood vessels within the Haversian canal and that damage to the vessel wall was accompanied by thrombosis. The bone died as a result of this altered blood supply. According to recent observations,[11] the primary damage is to the osteocyte. The blood vessels respond more slowly, with a thickening of the walls of arteries and arterioles. The decreased nutritional supply is a factor during long survival periods when the osteocytes which have been injured but not destroyed are attempting to recover. However, the damage to the osteocyte is often so severe that its death is rapid and nutritional factors are a secondary concern. The periosteum within the Haversian and Volkmann canals is also readily affected by rebound across these structures. Severe injury or death of these cellular elements of the periosteum will seriously delay healing of the irradiated area.

Apparently this was the situation which developed in the case reported here. There was an appreciable layering effect on the surface of the cortex, so that the back scatter contributed to the skin damage. The deeper-penetrating x-rays of the low-voltage therapy produced enough internal rebound to cause cessation of root growth in the irradiated area as well as alteration of the growth potential of the developing maxilla and mandible.

Unquestionably, in the case reported here the patient received an excessive x-ray dosage (3,500 r) as far as growth was concerned but only moderate dosage from the aspect of skin irradiation. In the jaws, where bone is interposed between the soft tissues of the cheek and the pharynx, the maximum medium-voltage x-ray radiation of bone should not exceed 35 per cent of the skin dosage that is tolerated elsewhere. The precise quantity of irradiation which stops tooth development or alters growth of the maxilla or mandible is still unknown. However, it appears to lie somewhere between 800 r and 1,500 r, depending upon the age and physical characteristics of the individual patient.

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Research and malocclusion

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IN THESE days of strong competitive bidding for every research dollar, the prevalence of a disability is often used as a measure of investigative need. The cancer people rightly point to the half-million cancer victims, and the heart people effectively stress the incidence of cardiac disease. The National Foundation justifies its continuing existence on the frequency of developmental defects of all kinds. Therefore, it is appropriate to begin this discussion with the simple observation that at least 120 million tooth-possessing Americans are currently afflicted with malocclusion. Yet data supplied by the National Institute of Dental Health reveal that, despite the prevalence of malocclusion, the total amount allotted by the United States Public Health Service for support of all dental research is only $5,777,000.00 for the current year, and of that total just $266,000.00 is "tooth-marked" for malocclusion. Worked out on a per-victim basis, this approximates one-sixth of one cent per person per year for research on malocclusion.

Thus, we begin with the facts that three-quarters of all Americans are walking examples of orthodontic need and that research into the causes of malocclusion receives only minimum support. These facts are dwarfed by our remarkable lack of knowledge of the causes of malocclusion and, therefore, of its prevention and ultimate cure. In contrast, coronary artery disease shows considerable evidence of stemming from disordered lipid metabolism, so that research support can be directed to basic lipid chemistry and to the investigation of genetic, nutritional, and emotional influences. As for the neoplasms, numerous co-carcinogens have been identified; these include penetrating radiation of many wave lengths, hydrocarbon distillates, and now several viruses. Experimental

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and epidemiologic evidence with respect to birth defects has similarly uncovered a whole series of important clues to be pursued in research. When it comes to malocclusion, however, although the incidence is high and the diagnosis is simple, the search for research directions has just barely begun.

Over the years, of course, many simple explanations for malocclusion have been advanced and then rejected. There was thumb-sucking, an adequate explanation for some malocclusions, but not for most. There was bottle-feeding, an explanation for malocclusion that is rarely heard today. There was the "genetic" explanation, which was adequate to explain familial predispositions toward occlusal disharmonies but which failed to explain the increasing population frequency. When the unitary explanations were exhausted, the multifactorial hypothesis was advanced for malocclusion; this yielded an equation with an unknown number of unknowns instead of just one.

No matter how many causes of malocclusion there may be, in the sense of the "first cause" or the "proximate cause," it is obvious that the underlying mechanisms involve disturbance of the synchronic growth of the teeth and their supporting structures. One set of structures may outpace the other; one center of maxillary or mandibular growth may respond normally, and another abnormally. It is for this reason that intensive research is needed—research on the development of the teeth, research on the growth of alveolar bone, and research on the membranous bones themselves. Such developmental research on how the facial bones grow and how the teeth develop and then migrate to oppose each other is basic research on malocclusion.

Earlier in the present century, an initial understanding of normal facial growth was sought by application of the simple caliper measurements developed by nineteenth-century anthropologists. These measurements, however, which were designed specifically for the characterization of populations and the comparison of individuals, had little to do with the way the skull, the face, and the jaws actually grow. The measurements were not the product of growth research; nor did they effectively elucidate growth. By measuring from one facial landmark to another, dozens of actual growth changes were lumped into one simple dimension.

The statistical methods employed were also unsatisfactory. For example, in the technique of reporting mean trends, vital information on *individual* growth differences was thrown away. It is impossible to generalize from the mean what proportion of children (either majority or minority) actually grows the way the mean suggests. The Gaussian statistics of the past century, while providing for the description of variability, also were not fully suited to the analytic task. As a result, many students got caught in the unnecessary argument over whether or not a given dimension or facial angle was variable, when the real problem was what the variability meant.

Thus, while carefully oriented radiographs added a valuable potential source of information on the growth of the head and face, it is clear that unsophisticated measures and inappropriate statistical analyses have failed to "squeeze the juice" of facial growth from otherwise excellent raw material.

By way of illustration, let us consider the mandible—that deceptively simple pair of hinged bones. Unlike the metacarpals or the digits (which grow rather simply), the mandible grows in all directions to an extent, and at relative rates that have not yet been determined. No single fore-and-aft measurement describes the complex of mandibular growth, for the mandible is capable of growing ten times as fast at one point as at another point immediately adjacent.

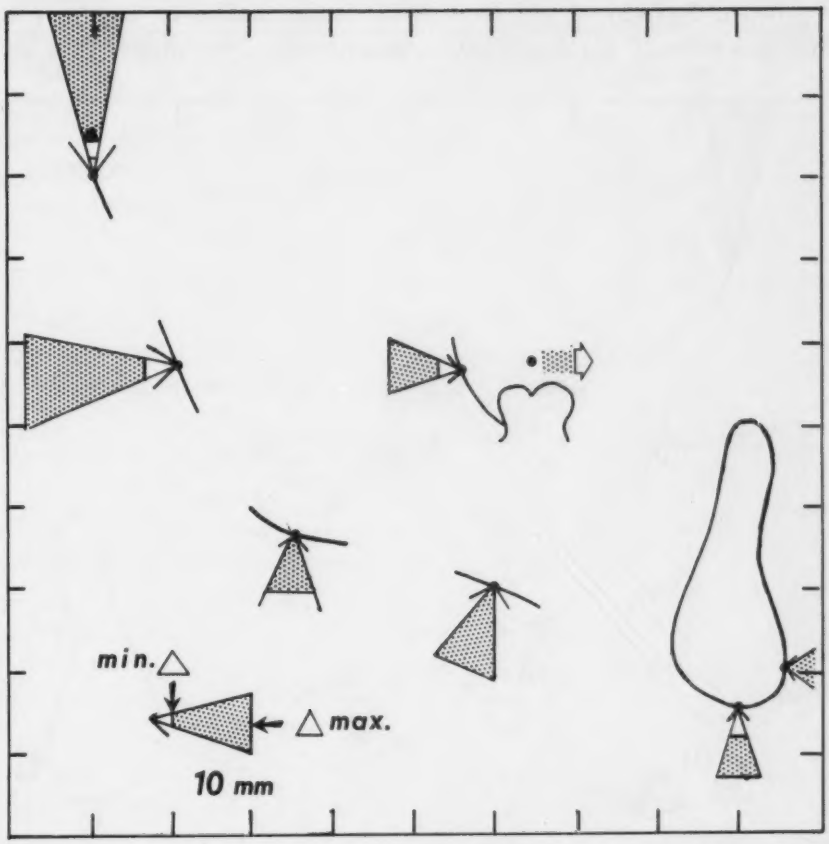

Fig. 1. Maximum and minimum eight-year increments at selected mandibular sites for a group of boys in the Fels Longitudinal Series. As shown in the scale diagram, there is considerable variability in localized growth between the ages of 10 and 18, and summation measurements would obscure localized growth changes.

Moreover, it is not likely that averaged trends or averaged increments adequately reflect growth at the symphysis, which can attain a given size in different ways in different individuals. Any adequate study of the postnatal growth of the mandible must involve serial longitudinal radiographs. The mandible must be fragmented into numerous seemingly independent parts, the separate growth rates of these parts must be measured, and then correlation matrices for the whole must be run. Moreover, in such atomistic studies any preconception that the mandibular growth pattern is essentially the same for all persons must be discarded. If everyone had the same mandibular growth pattern, individual

differences in relative proportions of the mandible would not exist; in fact, there might be no malocclusion!

It is perfectly possible to use serial longitudinal radiographs to measure individual differences in the growth rate (or growth increments) of different parts of the mandible. Such studies, interestingly enough, rapidly contradict common assertions and occasional critical comments on the growth of the mandible as a whole. On the one hand, there is no simple "regularity" of mandibular growth. Individual children differ quite markedly in the amount of growth of one part of the mandible as compared to the other. One child may

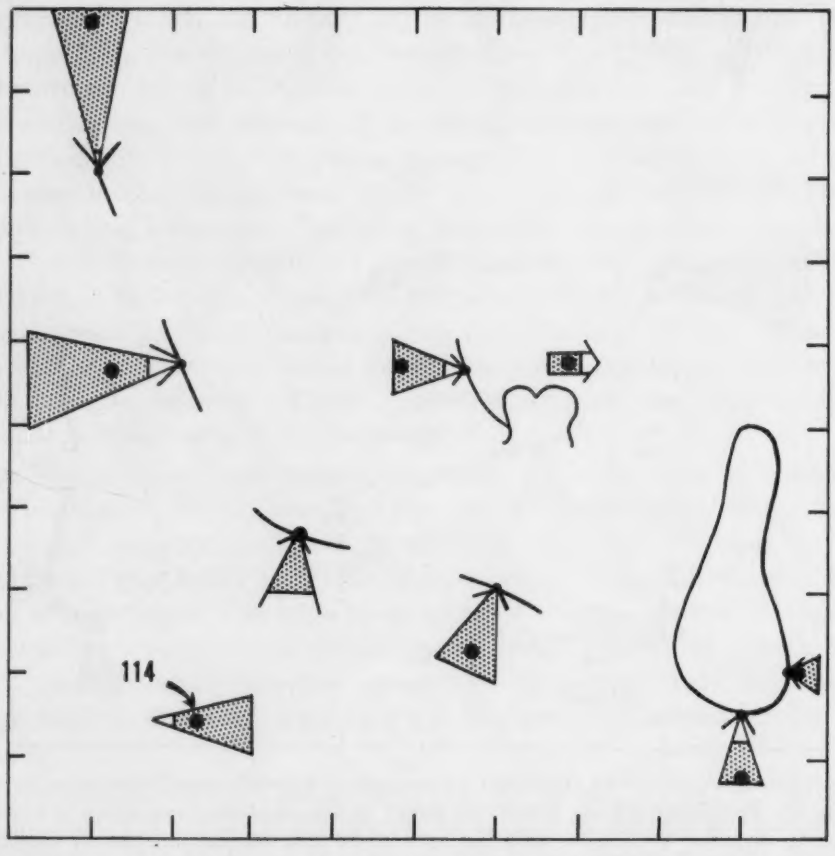

Fig. 2. Eight-year increments in mandibular size for Fels subject No. 114 (heavy dots) superimposed on the ranges shown in the preceding diagram. As shown, near-maximum increases in the condylar area, in symphysial height, and in the interior border of the mandible contribute to the marked elongation of this subject's lower face during the adolescent period.

show maximum growth in the condylar region or in the area of pterygoid attachment. Still another child may show the most growth at the bottom of the mandible, with very little of what is commonly called growth in "height." While these observations seemingly support the emphasis on the "functionally independent" and "evolutionarily separate" parts of the mandible, further studies of the interrelationships during the growing period are not necessarily in ac-

cordance with these latter suggestions. During the growing period intercorrelations of increments in mandibular growth are, indeed, moderate. There are marked individual differences, so that the growth of any one child's mandible does not necessarily represent the artificial trend for the population as a whole. Yet the growing parts of the mandible show enough communality during the incremental period to prove that the "functionally independent" parts of the mandible are not developmentally independent during growth (Figs. 1 to 5).

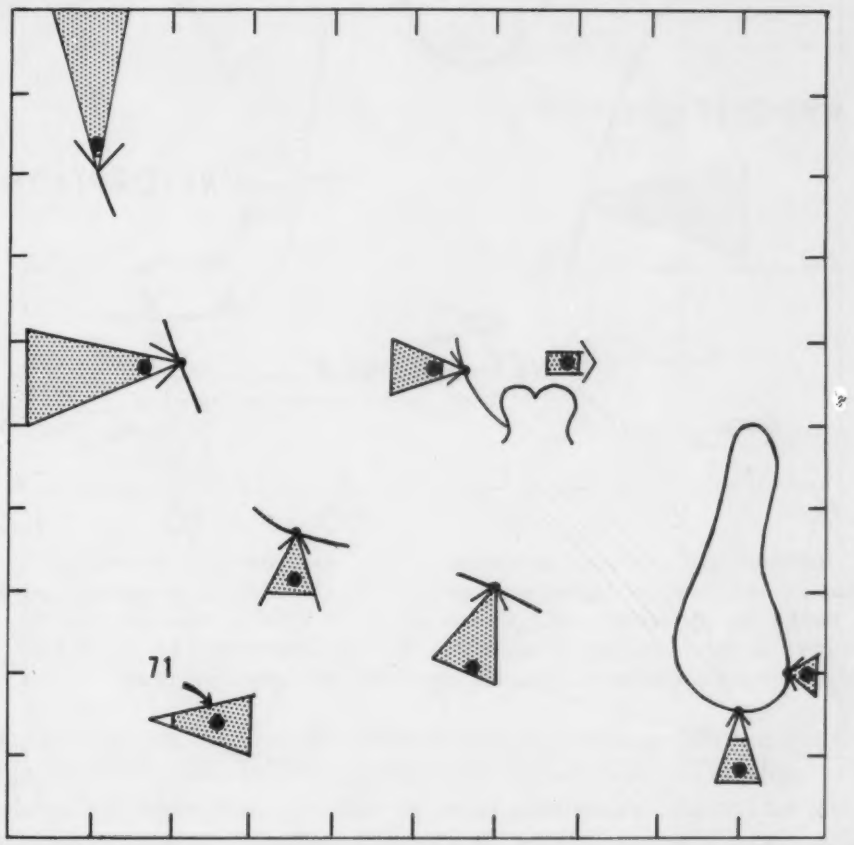

Fig. 3. Eight-year increments in mandibular size for Fels subject No. 71. In contrast to the subject shown in Fig. 2, his mandibular growth during adolescence has involved minimal changes in ramus height and rather little lengthening of the lower face, though with greater addition to the posterior and "angular" region of the mandible.

The growth of the mandible in man poses such experimental problems as the selective sites of action of growth hormone, a hormone that will soon be susceptible to direct measurement by immunochemical means. This will be an important advance in the study of mandibular growth, for individual differences in the rates of bone apposition and the rates of bone resorption currently need explanation. The role of various steroid hormones in both limiting and exaggerating mandibular size must similarly be elucidated in persons with endocrinopathies and patients who have been surgically castrated. The possibility of

hormonal intervention or hormonal orthodontics must always be considered.* There is no reason for orthodontics to remain forever a largely mechanical correction of fundamental discrepancies in facial growth when hormonal therapy can speed bone resorption, inhibit tooth movement, or both.

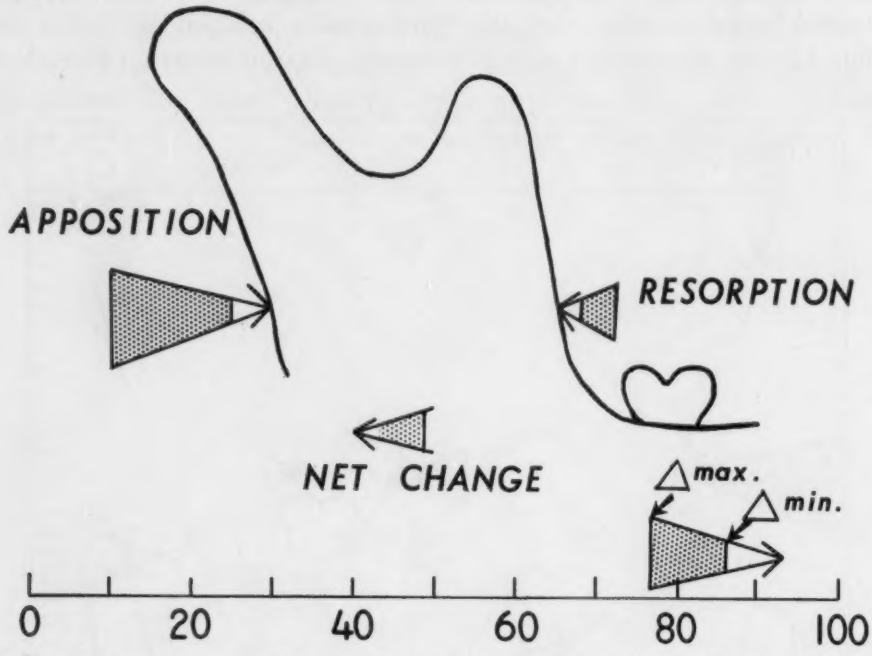

Fig. 4. Maximum and minimum increments (Δ) in resorption and appositional growth of the ramus in boys over an eight-year period. While the width of the ramus generally increases during the adolescent period, the net change in width is determined by the relationship between Δ resorption and Δ apposition. A wide ramus may be attained by a small amount of resorption, a large amount of appositional bone growth, or both.

Besides natural experiments such as those afforded by the endocrinopathies, metallic implants in monkeys and man must be studied and experimental studies involving embryonic transplants must be made to determine further how the mandible actually grows. All this is very fundamental research on growth, but it is essential to understand the normal development of the occlusion and therefore the causes of malocclusion. Such research will cost money, however, at least $2,000,000.00 a year (for 100 projects) at the very start.

Understandably, little attention has been paid to the prenatal growth of the face and jaws. It is also understandable that little work has been done on jaw relationships in the newborn, since technically such infants do not have any "occlusion" at all. There is good reason, however, for orthodontists to become interested in the early developmental horizon, even though this is far from the

*Recent successes in modifying hormones for particular therapeutic purposes point the way to their eventual use in controlling jaw-tooth development. Since a thyroid hormone lacking most metabolic effects has been developed for cholesterol regulation, and synthetic steroids have been designed to control ovulation, the possibility of a modified growth hormone that will create "room" in the mandible is far from remote.

age in which they traditionally have had maximum interest. There is increasing evidence that interruptions in the normal course of prenatal development can result in jaw malformations—some of them immediately apparent and others which do not appear in full force until later life.

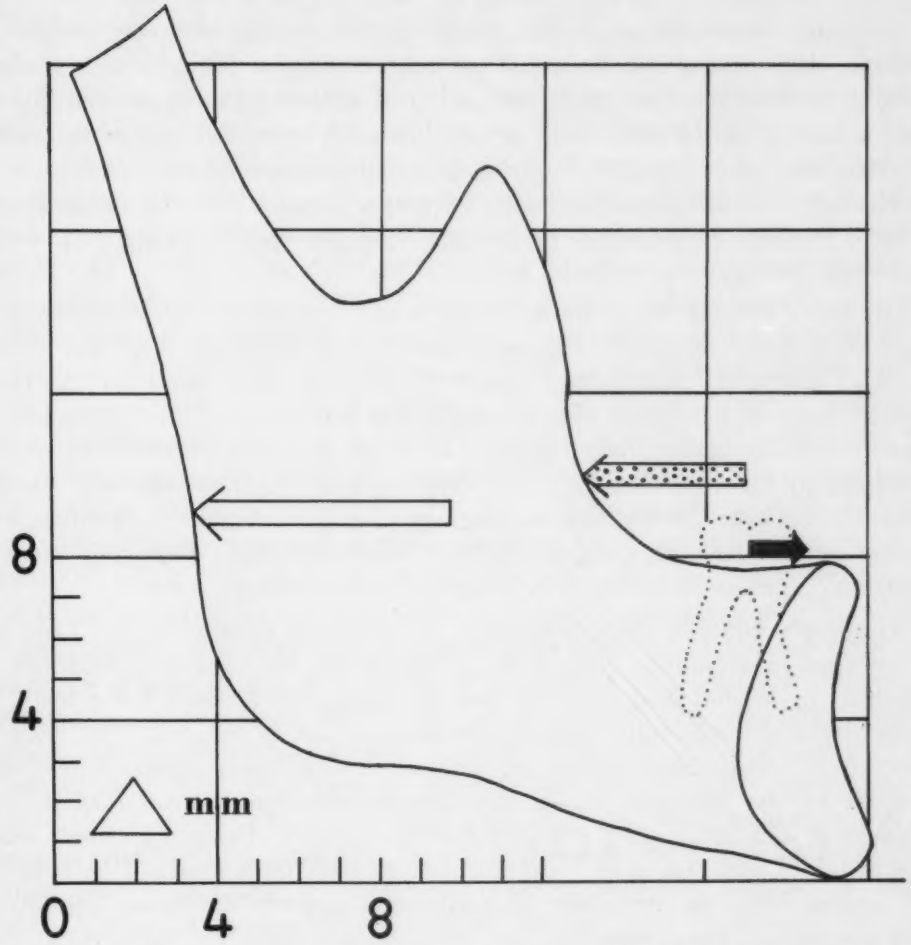

Fig. 5. A mandible drawn in proportion to the amount of change (Δ mm.) at various sites during the period from 8 to 18 years. As shown, the tooth-bearing area $I_1 - M_1$ actually decreases during this time, the symphysis gains moderately in height and thickness, considerable "basal" bone is added, the width of the ramus increases, and there is maximum growth in the condylar area. Clearly, simple summation measurements would not reveal individual differences in localized growth during this period.

Severe insults during prenatal development have long been known to cause defects of craniofacial form, such as cleft palates, harelips, micrognathia, oxycephaly, and the like. More recent studies in experimental teratology suggest that although less severe insults to the growing organism do not produce obvious defects at birth, their impact may be seen in the form of disturbed jaw relationships and abnormalities of dental development. First demonstrated by Deuschle and Warkany,[1, 2] who used subclinical vitamin deficiencies at critical

points in the developmental horizon, comparable results have been obtained with a variety of teratogenic agents and vitamin insufficiencies. Temporary adrenal malfunctions on the part of the mother or a transient interruption in the uterine blood flow may underlie some of the facial abnormalities that we see in growing children.

For this reason, experimental teratology is also research on malocclusion. Vitamin deficiencies and excesses beyond the levels previously investigated, nutrient deficiencies, radiation effects, viral diseases that pass the placental barrier, and even hormones and antibiotics used to maintain the conceptus or to minimize disease may now be listed as *possible* causes of malocclusion in man. Particularly in those cases in which hormonal therapy in early pregnancy has resulted in sex reversal of the offspring,[3, 4] there is special reason to investigate tooth–jaw development in later life.

In many infants the prenatal course is far from placid. In some cases there has been a threat of abortion in early pregnancy. In others there has been evidence of disturbed functioning and hyperactivity, even prior to the twenty-seventh week of gestation. Many infants manage to come into the world in a state of extreme prematurity. These infants are not just adventurous; they are hastening to leave an unsatisfactory environment[5] that has already caused irreparable damage. Careful epidemiologic studies on threatened abortions, hyperkinetic fetuses, and the smallest of the premature infants may well reveal very important clues concerning the etiology of malocclusion.

Curiously enough, the development of the teeth themselves has been given almost studied avoidance. The teeth, after all, are the organs that do not meet and must be herded into line. Yet the developmental course of the teeth, both prenatally and postnatally, is still remote from active research. This may be a reflection of occupational fatigue, of necessary de-emphasis on an all-too-familiar view, or of the mistaken belief that tooth formation has been investigated, normalized, tabulated, and finalized for all eternity. Certainly, there are numerous tables and charts of tooth formation, with data glorified in cold print and colored ink, but the neatly printed word and the attractive lithographed plate are not always correct.

Most tooth-formation tables, with the exception of those that hark back to the most remote era, involve the published values of Logan and Kronfeld.[6, 7] Often without proper credit to these pioneering investigators, the Logan-Kronfeld values have been abridged, summarized, and frequently altered by misunderstanding and mathematical error.[8] Textbook authors have adopted the norms as their own, in some cases mistakenly crediting four or five different sources for one set of values! Yet the Logan-Kronfeld data on tooth formation so frequently quoted are based on a total of but twenty-six juvenile cadavers.[6] Most of the cadavers were the bodies of infants, of whom many were defective and all were debilitated at the time of death. From such limited and abnormal human material have come the "norms" for tooth formation. However, Logan and Kronfeld never intended their values to be used as tooth-formation norms covering a twenty-year span for both sexes.

Thus, when calcification of the teeth within the jaws is studied more extensively, using thousands of serial radiographs instead of only a few, tooth formation turns out to be far more variable than the published norms suggest. Our own estimate of variability for tooth formation is three times as great as the Logan-Kronfeld values,[9, 10] which is hardly surprising since we used 3,500 radiographs instead of twenty-six radiographic and histologic preparations.

Yet, even with the new and improved measures of variability, we find that tooth formation is actually less variable than many other maturational measures. We find also that the teeth are "conservative" for a rather simple reason. They tend to respond but little to even gross alterations in the developmental rate. Working on children with endocrinopathies, normal children, and children at the extremes of physiologic development, we agree with Prader[11, 12] that the teeth barely accelerate in the face of gross advances in maturation and fall only moderately behind even when bone age is retarded as much as ten years.

In fact, the independence of tooth formation and general development during infancy and childhood is remarkable. There is no evidence whatsoever that fatter children tend to be advanced in tooth development; thus it would seem that nutritional mediation of tooth development in childhood is unlikely. Children who are advanced skeletally, though they are bigger in general, are not notably ahead in dental development.[13] The autonomy of the teeth during infancy and childhood, as well as their tendency to progress along a genetically determined course,[14, 15] again points out the uniqueness of dental development.

During adolescence, however, there is a greater correspondence between the developing tooth and sexual and somatic status. Certain steroid hormones appear to be capable of speeding up the development of *some* teeth. Correlations between menarche and eruption of the second molar[16] and correlations between second molar calcification and tibial union in both sexes are of a moderate order of magnitude.[17] Yet, while steroids of testicular and ovarian origin appear to have an acceleratory effect on tooth formation and movement (as has been shown in experimental studies[18]), a major discrepancy still remains to be explained. In certain endocrinopathies involving grossly advanced sexual maturation, in Albright's syndrome, and in precocious puberty in general, the formation of the teeth is not markedly advanced.* Thus, we do not really know which steroid hormones speed up tooth formation and movement. We do not know whether there are particular steroids that affect tooth calcification and others that do not, or whether the teeth are susceptible to hormonal mediation at particular phases of development and not at others.

If there is any question as to whether the developmental timing of the permanent teeth can relate to ultimate occlusal problems, variations in the formation timing of the mandibular third molar may be cited with particular emphasis. The mandibular third molar, as many of us know from regrettable

*In the case of Lina Medina, the famous 6-year-old mother from Lima, Taft reported no advance in tooth formation despite the child's obviously accelerated maturation. Since we have also observed no advancement in tooth formation in certain cases of precocity[12] we conclude that either some steroids may lack effect on the dentition or at some stages of development the teeth are refractory to steroid mediation.

personal experience, is a peculiar tooth. It is a tremendously variable tooth, which begins to calcify in the eighth year in some children and not until the fifteenth year in others. It is an independent tooth, being even less related to general and physical development than is average for the remainder of the dentition.[19]

Yet the mandibular third molar is remarkably consistent within itself, showing a more consistent tendency toward advancement or retardation than any other tooth that we have considered. Its developmental course actually predicts its eruptive future. Early formation of the third molar goes hand-in-hand with early movement through the jaws and apparently uncomplicated eruption. An early-forming third molar is more likely to reach the occlusal level without marked difficulty. Late formation is another matter, however, being associated in the majority of cases with late and incomplete or blocked movement. Thus, the developmental status of the third molar, the rate at which it forms in the jaw, is related to its later occlusal history, as has been observed also by Danish investigators interested in the familiar question of space or "room"[20] in the mandible.

The third molar further deserves mention because it provides an opportunity of investigating a long-term (secular) trend which possibly results in an increasing incidence of impactions. From our studies, we know that third molar formation has little relationship to the timing of maturation. Yet, as is generally known, the growth and development of the jaws has much to do with somatic and sexual maturation in general. Thus, the mandibular third molar could represent a particular situation in which the trends toward more recent maturation may have interrupted the normal synchrony between jaw and tooth development. Needless to say, studies on the timing of formation and movement of other critical teeth, among them the second premolar and canine, may help to elucidate their particular roles in the development of dentofacial disharmonies. We all know the difficulties that late eruption of the second premolar or canine can cause. We do not know why those two teeth are late in specific cases. Here, again, we have a situation in which knowledge of the timing of tooth formation may shed important light on the development of occlusal disharmonies—all the more reason to return to the teeth in research on malocclusion.

The greatest single advance in research on malocclusion has been, of course, the wide-spread utilization of standardized head plates. To some extent, however, their potential accuracy has been dissipated by the unique custom of tracing the films and then measuring the tracings, a habit not found among other users of radiographs. Moreover, advances in "cephalometry" have been delayed by the failure to develop a satisfactory Cartesian or tri-coordinate (X-Y-Z) system of measurement. Thus it is that the posteroanterior view remains largely superfluous, while a truly three-dimensional analysis of total tooth movement, or total facial growth, has yet to be made. Certainly, the face and its growth occupy more than one plane of space and must be measured accordingly.

Now many problems in the growth of the face and the development of the teeth can be solved only through the use of fully longitudinal serial head plates.

I have already commented on serial longitudinal oblique-jaw views, the key to modern studies on tooth formation. Such longitudinal collections of head or jaw films are extraordinarily valuable, for they contain precious data that can be mined again and again, each time for a different investigative purpose. A completed series of skull plates, even on one child, is a valuable possession, and there are many investigators who could benefit from even a one-child series.

In this country there are numerous collections of longitudinal and partly longitudinal lateral-head and jaw plates of which workers in craniofacial growth are not always aware. Although most investigators will think immediately of the original Bolton-Broadbent collection or the semilongitudinal collections at the Philadelphia Growth Center, other collections at the Harvard Longitudinal Studies of Growth and Development and the Child Welfare Council at Denver may be unknown to them now. There are collections in St. Louis, Missouri, and Lincoln, Nebraska. There are longitudinal and semilongitudinal collections maintained by individual practitioners. Some of these collections are in danger of being thrown out completely, and others sit totally unused because their existence is unknown.

The radiographic collections now languishing on orthodontists' shelves have great value. Some of the radiographs which date back twenty-five years and more can tell us about tooth formation rates an entire generation back. Others comment silently upon the tendency of particular teeth to return to their prestressed places. Why should such important films go into the incinerator at spring cleaning time or burn up by the hundreds at the behest of somebody's widow?

I should like to propose a group effort to establish a radiographic master file. One part of the file would include truly longitudinal head plates of normal children; these could be originals or duplicates from the major growth centers. Another part would be a registry of completed cases contributed by individual orthodontists from all over the nation. A third part of the master file would include frank pathologies, developmental defects, endocrinopathies, and so on. There is a precedent for such activity in the National Tumor Registry and in the new National Study of Birth Defects. There is little doubt that such a collection of jaw–head radiographs would prove immensely rewarding and worth far more than the moderate initial cost.

CONCLUSION

I have wandered relatively far and rather wide on the subject of research and malocclusion, though without transcending the natural limits of the subject itself. Malocclusion is a health problem of major magnitude; yet it is underemphasized, demonstrably underinvestigated, and grossly undersupported as far as research is concerned.* Because the orthodontist is too often thought of as someone who can make a "slick chick" out of an "ugly swan," investigators and grant-giving foundations alike have seized upon other problems seemingly

*The total expenditure for research on malocclusion currently approximates 2 per cent of our annual expenditures for playing cards and 1/25 of our expenditures for wave-set preparations.

more needful of research effort and investigative dollars. There are tremendously overpopulated areas of research today in which almost duplicate grant applications point to a paucity of new directions. This is not true of research on malocclusion, which is still open with endless avenues to explore.

To the old nursery-rhyme question: "Mary, Mary, quite contrary, how does your garden grow?" we have a thousand answers. Much is known about geotropisms, heliotropisms, and the effects of temperature, moisture, light, and nutrients. But how does Mary's *face* grow? Literally more is known about the jaw growth of snapdragons than the jaw growth of man. Various malocclusions in cattle (which have obvious economic importance) currently receive more research attention than jaw–face disharmonies in human beings.

We need research on the bones of the face that do not behave like typical bones, on alveolar bone (which is a very peculiar type of bone), and on the teeth (which are not bones at all). Such research on dentofacial growth is basic research, research on occlusion, and at the same time it is research on malocclusion as well.

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Swallowing patterns of a normal-population sample compared to those of patients from an orthodontic practice

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INTRODUCTION

RECENTLY published reports by Straub[1] regarding abnormal swallowing habits have prompted many orthodontists to re-examine patients for swallowing abnormalities. Straub has pointed out that the act of swallowing occurs more than 2,000 times in a twenty-four hour period, with approximately 1½ pounds of thrust exerted by the tongue against the teeth and supporting structures. The relationship between tooth position and tongue pressure is obvious. Abnormal tongue movements during the act of swallowing will produce abnormal tooth positions.

Although there is much difference of opinion among orthodontists regarding technique and philosophy of treatment, there is almost universal agreement as to the difficulty of maintaining correction in an open-bite case. Since the tongue movements play such an important role in causing both anterior and posterior open-bites, as well as in reproducing them after treatment, the importance of investigating the frequency of swallowing abnormalities is apparent.

Cognizance of the abnormal swallowing problem has stimulated many orthodontists to check carefully the swallowing mechanisms of all their patients. Orthodontists with whom I am acquainted[2-5] report that more than 60 per cent of their patients show abnormal tongue and facial muscle movements during the act of swallowing. Some orthodontists, including Tweed,[5] are reporting that 80 per cent of their patients are abnormal swallowers. In a study of 500 patients attending an upper respiratory research clinic, Leech[6] found that 43 per cent had atypical swallowing patterns.

This thesis, which was given as a partial fulfillment of the requirements for certification by the American Board of Orthodontics, is being published with the consent and the recommendation of the Board, but it should be understood that it does not necessarily represent nor express the opinion of the Board.

Some investigators[7, 8] have found abnormal swallowing, accompanied by tongue-thrust, in cases of deep overbite. Careful checking of my own practice and the practices of my associates indicates that this is true. In these deep overbite cases, the effect of tongue pressure is often shown by the forward tipping of the upper anterior teeth accompanied by diastemas between the four upper incisors. Inasmuch as this is a problem which frequently confronts the orthodontist, a study of its cause would be conducive to better orthodontics.

Straub[1] states: "The abnormal swallowing habit seems to be the direct result of improper bottle feeding." In planning this thesis, I thought that information regarding the prevalence of abnormal swallowing habits in a normal-population sample would provide some of the missing links in the chain of evidence to confirm or deny Straub's conclusion regarding the cause of the problem.

Although this article is not intended as a critical review of the current methods of retraining the perverted swallowers, it does seem appropriate to describe what is being done in my practice to analyze and evaluate the problem.

REVIEW OF THE LITERATURE

The act of swallowing has attracted the attention of investigators since ancient times. Surprisingly enough, the findings in recent studies of swallowing in which cinefluorographic techniques were used are quite similar to those published by Magendie[9] in 1822. Magendie was the first to simplify the study of the complexities in the swallowing mechanism by dividing the act into three stages: (1) oral, (2) pharyngeal, and (3) esophageal.

Strang,[10] using these three divisions of the swallowing act, describes in detail the various movements as follows:

> Stage I. 1. The bolus is formed on the dorsum of the tongue by the action of the intrinsic and extrinsic muscles of this organ, aided by the muscles of the face bordering the mouth and those of mastication.

This statement by Strang would be questioned by most investigators, inasmuch as Winders[11] has shown that during deglutition there is no measurable pressure by the buccal or labial tissue on the teeth, either in the upper first molar region or on the labial surface of the upper central incisors.

Strang continues his description of the three swallowing stages as follows:

> 2. There is a sucking action to center the bolus on the tongue. This brings into activity the muscles that depress the mandible and those that aid in the production of the vacuum within the mouth. These latter are the canini and triangulares, which draw the corners of the mouth together and the fibers of the orbicularis oris and mentales which protrude the lips.

Again, Straub[1] seems to differ with the foregoing, for he states: "It was pointed out earlier that in the normal act of deglutition, the facial muscles of expression are not used; and any observed changes in these muscles, just prior to or during the act, usually indicate an abnormal swallowing habit."

The rest of Strang's description follows:

The external pterygoids are the depressors in action, while the genioglossi, the chrondroglossi, the styloglossi, and the longitudinalis superioris all act in forming the sucking trough on the tongue.

3. The tongue is next raised rhythmically from front to back, forcing the bolus through the fauces. The tongue action is due to the following muscles:
   (a) The intrinsic tongue muscles, i.e., longitudinalis inferioris and transversus.
   (b) The styloglossi and glossopalatini muscles.
   (c) The suprahyoid muscles, viz., the mylohyoid, geniohyoid, digastric, and stylohyoid.
4. The teeth may be forced strongly together in occlusion by the muscles of mastication or they may remain slightly separated.
5. The pharynx is raised and opened by the stylopharyngei, the pharyngopalatini, the salpingopharyngei, and the middle and inferior constrictors of the pharynx.
6. The larynx is raised and brought forward by the elevators of the hyoid bone, i.e., the suprahyoid group acting through the attachments between the hyoid bone and the thyroid cartilage of the larynx.
7. The bolus is pushed into the pharynx by the tongue.

Stage II.

1. The nasopharynx is closed off by the contraction of the levator veli palatini which raises the soft palate and the tensor veli palatini which makes it tense, by contraction of the pharyngopalatini muscles and the elevation of the uvula from the action of the azygos uvulae muscle. This latter structure fills in the space between the two pharyngopalatini muscles.
2. The fauces closes, preventing regurgitation into the mouth. This closure is caused by the contraction of the glossopalatini muscles and the continued elevation of the base of the tongue that results from the raising of the hyoid bone by the suprahyoid group of muscles.
3. The opening into the larynx is closed by the downward and backward movement of the base of the epiglottis and by the adduction of the vocal cords. The adduction of the vocal cords is effected by the contraction of the crico-arytenoidei laterales and the arytenoideus which constrict the glottis by rotating the arytenoid cartilages.

   The pulling down of the base of the epiglottis is produced by the action of the thyro-epiglottideus and the aryepiglottici which pull the epiglottis downward and backward and by the thyroarytenoidei which pull the arytenoid cartilages forward toward the base of the epiglottis. The aryepiglottici, thyro-epiglottideus and the thyro-arytenoidei form a triangle of muscular tissue. Consequently, when in concerted action, they pull toward a common center and in this action the base and the lower part of the epiglottis is (are) pulled downward and backward into the opening of the glottis like a cork being drawn into a bottle from an action within the bottle itself.

   The elevation and forward position of the larynx and the balling up of the tongue also facilitate the repositioning of the epiglottis.
4. The pharynx is widened laterally by the action of the stylopharyngei and anteroposteriorly by the upward and forward movement of the hyoid bone and thyroid cartilage.
5. The bolus is shot downward into the esophagus by the contraction of the three constrictors of the pharynx. The hyoglossi also aid in this

action by producing a secondary movement of the tongue backward and downward.

6. The hyoid bone is pulled backward at this time by the stylohyoid muscles and the posterior bellies of the digastrics.

Stage III. This is the esophageal stage in which the bolus travels to the stomach by peristaltic action of the esophagus.

Strang's detailed description indicates that swallowing is an extremely complex function. Most of Stage II and all of Stage III are involuntary reflexes, and this undoubtedly prevents some perverted swallowing.

Only a few articles were found regarding experiments with animals. In a research project, Bosma[12] used an electromyograph to study deglutition in the monkey, cat, and dog, involving twenty-two muscles of the mouth, pharynx, and larynx. This study showed definite control centers in the brain for deglutition. "Motor neurons from cervical 3 to the mesencephalon are reproducibly controlled in an intricate pattern of excitation and inhibition specific to deglutition."

Truesdell and Truesdell[13] made a rather comprehensive study of deglutition, including that of different mammalian species. They state:

> For example, in a cow the lips have no part whatever in the function of deglutition; but each time the cow swallows her cud, the temporal and the masseter muscles can be clearly seen to tense with full masticating power. Furthermore it can be seen that they do not relax until the cud, or bolus, has passed the larynx. So far as we have been able to observe, deglutition occurs in all mammals below man in a similar manner.

Some very comprehensive research on normal deglutition is reported by Field.[14] Ramsey and associates[15] also made a cinefluorographic analysis of the mechanism of swallowing. Atkinson and colleagues[16] published a fine paper entitled "The Dynamics of Swallowing." The new tool of cinefluorography was used in all of these studies to confirm the swallowing mechanism as it is now described.

None of these physicians mentioned the factor of abnormal tongue movement or lip function at the beginning of or during the swallowing act. This seems surprising, since a large percentage of persons show atypical tongue movement during deglutition. Leech[6] reported that 43 per cent of 500 patients attending the upper respiratory clinic showed atypical swallowing. Some orthodontists report that 80 per cent of their patients have tongue problems during deglutition.

Straub[1] presents a very good description of the atypical or reverse swallower:

> In persons who swallow abnormally, there is a typical facial grimace, in which a line runs down from the wing of the nose to the orbicularis oris, and the lips are protruded. This is a result of abnormal positioning of the tongue during perverted swallowing. The spaces that exist between the teeth were caused by a positioning of the tongue which separated the teeth. Holding the tongue in a forward position prevents normal deglutition.

In a study conducted by Nieberg[17] at the University of Kansas City Dental College, the electromyographic technique was used on twenty-nine patients.

It was found that three basic patterns of deglutition exist. Nieberg describes them as follows:

> (a) The first pattern, which will be called "normal" exhibited marked contraction of the masseter muscles and limited activity from the labial and mentalis musculature.
> (b) The second pattern, which has been referred to as "visceral type," demonstrated little or no activity from the masseter and considerable contraction from the mentalis muscles. Slight activity was evident in the mandibular orbicularis oris.
> (c) The third pattern manifested marked activity of the lower lip and mentalis muscles and considerable contraction of the maxillary orbicularis oris. Masseter activity was at a minimum.

Winders,[11] at Northwestern University, utilized very delicate strain gauges connected to an oscillograph which accurately recorded pressure from the lips, cheeks, and tongue during various movements. His conclusions were as follows:

> There is no apparent increase of pressure on the buccal surfaces of the maxillary first molar or the labial surface of the maxillary central incisor during the normal swallowing act.
>
> There is an increase in pressure on the mandibular first molar during the act of normal swallowing.
>
> There appears to be more pressure exerted on the dentition by the tongue than by the buccal musculature during speech.

Again, in a discussion of his work, Winders states:

> There is not the balance of the musculature between the buccal and lingual sides of the dentition; the position of the teeth is dictated primarily by the skeletal base, and only in extreme changes in pressure, as in thumb sucking, incurred aglossia, macroglossia, progressive muscular dystrophy, muscular paralysis, etc., can a change in the position of the teeth be expected.

Some excellent research in muscle function and malfunction has been done in England within the last fifteen years by Rix,[7] Tulley,[18] and Gwynne-Evans.[19] In the summary of his paper entitled "Adverse Muscle Forces," Tulley says:

> The role of circumoral muscles in influencing tooth position has been discussed. Emphasis has been placed on the necessity to distinguish between bad muscular habits, which can be eliminated with treatment and exercises, and the more innate behavior which may resist change. It is this subtle difference which is so important in assessing stability of repositioned teeth.

To summarize the findings published in the literature, a few quotes from Bagg[20] would seem in order. Bagg divided his discussion into four sections: (1) etiology, (2) recognition of the habit, (3) effect of the habit, and (4) treatment of the perverted swallowing habit.

In discussing etiology, he points out that Straub's findings indicate that improper bottle feeding is responsible for adverse swallowing habits. Strang[10] attributes this condition to "an unbalance in the mechanism of nervous control of this function, for it is always seen in high-strung children who border on states of general in-coordination and muscle perversion. This, of course, is not

the primary cause, as there must be some underlying factor that has produced the condition of unbalance in the nervous centers.''

Rix[7] associates perverted swallowing habits with upper respiratory conditions, such as colds, catarrh, ''sniffles,'' sore throat, and earache. Hereditary factors are regarded by all writers as a cause of atypical swallowing in cases involving a jaw-tooth relationship conducive to open-bite.

In discussing recognition of the habit, most investigators agree that any action of the muscles of facial expression during swallowing is abnormal. It is universally agreed that perverted swallowing takes place with the teeth apart, so that the tongue slips through the occlusion and contacts the anterior teeth and the lips.

The effects of the adverse swallowing habit upon the teeth and supporting structures are recorded in the literature as follows:

1. Narrowing of the upper arch or a contracted maxilla.
2. Protruded upper anterior teeth with either a close-bite or an open-bite relationship.
3. Diastemas between upper and/or lower anterior teeth.
4. Lingual displacement of the lower anterior teeth in certain cases showing a circumoral tension.

There seem to be several principal approaches to the problem of the perverted swallowing habit. First is the use of appliance therapy to restrict the activity of the tongue. Appliances of the Monobloc or Andresen type have been used for this purpose. Some othodontists construct a Hawley type of retainer with lingual extensions to prevent tongue-thrust. The molar-to-molar lingual arch is frequently used, with spurs soldered to the anterior portion to discourage tongue-thrust. In using this appliance, Ricketts[21] claims a greater advantage if it is placed on the lower lingual arch rather than on the upper arch.

The second approach to atypical swallowing problems is the exercise method. This procedure has had many advocates in the past, including Alfred P. Rogers[22] who has written on this method. Speech therapists in the Midwest and West Coast areas have added their thinking and techniques to this muscle-training approach with the result that the abnormal swallowing habit has been eliminated in numerous cases. The success of this latest collaboration to control perverted swallowing habits can be judged by future research in the field.

A third method of treatment was reported by Lambert[23] in a thesis entitled ''Hypnotherapy in the Control of Tongue Thrusting Occurring During Perverted Swallowing.'' For this study, Lambert used twelve patients who exhibited perverted swallowing habits. Ten of the twelve were reported to have been cured by hypnotherapy. Lambert also mentions the need for reinducing the successfully treated cases at regular intervals for the purpose of fortifying the results.

PROCEDURES

Four hundred ninety-seven orthodontic patients from the practice maintained by J. Victor Benton, Robert F. Malone, and myself were tested for

tongue-thrust and facial grimace during the act of swallowing. This was done by squirting a small amount of water into each patient's mouth and asking him to swallow. This was repeated if the first swallow did not give the operator a clear indication of the tongue movements and the facial muscle action. Following the use of the water, the operator placed his thumb under the patient's chin and retracted the lower lip with his forefinger. The patient was then asked to swallow with nothing in his mouth. This provided a double check on the first swallow, and it also revealed the presence or absence of anterior or posterior tongue-thrust.

TONGUE THRUST

Deep Overbite						Normal Overbite						Openbite					
Grimace			No Grimace			Grimace			No Grimace			Grimace			No Grimace		
I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III

NO TONGUE THRUST

Deep Overbite						Normal Overbite						Openbite					
Grimace			No Grimace			Grimace			No Grimace			Grimace			No Grimace		
I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III

Fig. 1. The chart used to tabulate results of swallowing tests. The pupils who seemed to need no orthodontic service were indicated in red; the posterior tongue-thrust was designated by an asterisk (*).

The purpose of these tests was not mentioned or discussed in the presence of the patient being tested, since it was thought that an awareness of the problem might affect his performance. This belief is borne out by the fact that if the patient is taught to swallow correctly he will do so while making a conscious effort and while being observed by the doctor. When he swallows during an unrelated conversation, however, his tongue may be seen to slip between his anterior teeth.

The following data were recorded (Fig. 1) for each patient tested:

1. Presence or absence of tongue-thrust and designation as to whether the tongue-thrust is anterior or posterior.
2. Presence or absence of facial grimace.

3. Type of occlusion present (Angle's Class I, II, or III).
4. Type of overbite or open-bite and whether anterior or posterior.
5. Name, sex, and age of each patient. (This information was obtained primarily for future use in assisting the patients with perverted swallowing habits.)

The terms, as used in the swallowing tests, are defined as follows:

Anterior tongue-thrust—The movement of the tongue between the upper and lower incisors so that it is visible to the operator.

Posterior tongue-thrust—The movement of the tongue between the upper and lower buccal teeth, posterior to the canine, which may be either unilateral or bilateral.

Grimace—Any movement of the muscles of facial expression during the act of deglutition.

Deep overbite—The lower incisors touching the palatal tissue when the teeth are occluded.

Normal overbite—Any overlap of the upper and lower incisors in which the latter do not contact the palatal tissue.

Open-bite—No overlap of the upper and lower incisors; also cases showing overjet in which the lower incisors do not occlude with the palatal tissue.

Type of malocclusion—Classified according to Angle's Classes I, II, and III.

The findings from testing of the 497 orthodontic patients were compared with those obtained from identical testing of a group of 290 elementary school pupils ranging in age from 5 to 12 years. This latter group served as a normal-population sample. Inasmuch as no remedial treatment was intended for the school group, no record was made of the name, age, or sex of each child. Previous to the testing, however, the mother of each child had been asked to indicate on a printed form whether as an infant the child had been fed by bottle, by breast, or by a combination of both. When these forms were returned, the names of the children reported to have been breast-fed were recorded as a part of their swallowing-test data. I then had a telephone conversation with each mother to rule out any misinterpretations of the printed form.

The orthodontic patients were not checked with reference to breast feeding, since the case histories of these children had not included this information and since considerable change in occlusion had already occurred in many of the patients as a result of appliance therapy. In fact, I had the strong impression that, as a result of improved tooth position, some patients whose original casts had shown characteristics of tongue-thrust demonstrated no tongue-thrust or grimace at the time of this investigation. This impression, of course, could be validated only after intensive research. If the premise were true even in a few cases, it would negate any correlation between breast feeding and atypical swallowing habits if the data were taken during orthodontic treatment.

OBSERVATIONS

The tests revealed a higher percentage of tongue-thrust during swallowing in the orthodontic patients than in children of the normal-population sample. Of the 497 orthodontic patients, 312 (62.8 per cent) demonstrated a tongue-thrust. Nineteen (6 per cent) of the 312 had a posterior tongue-thrust.

Among the 290 elementary-school pupils, 165 (56.9 per cent) showed a tongue-thrust and one showed a posterior tongue-thrust.

Deep overbites were revealed in quite a number of children from both groups. In the normal-population sample of 290 children, 119 (41 per cent) had deep overbites. Eighty-two (68.9 per cent) of the children with 119 deep overbites demonstrated a tongue-thrust. In other words, in the normal-population sample, more than two-thirds of the children with deep overbites had atypical swallowing habits.

Among the 497 orthodontic patients tested, 277 (55.7 per cent) showed lower incisors touching palatal tissue (tabulated as deep overbites). The percentage of deep-overbite cases in this group would have been much greater, except for the fact that in many of the cases orthodontic therapy had corrected the problem before the study was made. Of the 277 deep-overbite cases, 156 (56.3 per cent) showed tongue-thrust.

Tabulations of several tests from both groups revealed the presence of a grimace with no accompanying tongue-thrust. In the normal-population sample, eleven (3.7 per cent) of the 290 children showed a definite change in the muscles of facial expression, with no tongue-thrust discernible by the operator. Among the orthodontic patients, 9.2 per cent showed some form of grimace with no tongue-thrust.

In the opposite vein, three school children showed no grimace but had a definite anterior tongue-thrust. Eight orthodontic patients showed a posterior tongue-thrust with no grimace.

The largest number of atypical swallowers found in the normal-population sample had Class II malocclusions with deep overbites. Abnormal swallowing was seen in sixty-three (79 per cent) of the total of seventy-nine cases of Class II deep overbite. In the orthodontic group, ninety-eight (63 per cent) of the 156 children with Class II deep overbite were atypical swallowers.

With very few exceptions, the children with open-bite were found to be indulging in atypical swallowing with tongue-thrust. Of the fifty-six school children with open-bites, only one did not demonstrate a tongue-thrust. Six of the eighty-four orthodontic patients with open-bites could keep their tongues out of the openings while swallowing.

For each child in the elementary school group, notations were made designating whether or not there was any indication of a present or future need for orthodontic treatment. In my judgment, 112 (38.6 per cent) of the 290 children examined showed normal dental development, tooth position, and jaw relationship for their ages. It is interesting to note that ninety-two of these 112 children showed no abnormal swallowing habit. To put it another way, 82 per cent of the children who appeared to have no need for orthodontic service also had normal swallowing patterns.

In response to the questionnaires regarding breast feeding, fourteen children in the school group were reported by their mothers to have been breast-fed as infants. However, telephone conversations with these mothers revealed that ten of the fourteen children had used bottles for fruit juice and/or water, leaving only four who had never used a bottle for any kind of liquid. These four children had been fed from a cup when supplemental nourishment was required. Two of them had anterior open-bites with atypical swallowing patterns, but neither indulged in finger- or thumb-sucking. The other two children showed normal deglutition.

Table I. *Tabulation of findings*

	Normal-population sample	*Orthodontic patients*
Tongue-thrust during deglutition	165 of 290 (56.9%)	312 of 497 (62.8%)
Deep overbite cases showing tongue-thrust while swallowing	82 of 119 (68.9%)	156 of 277 (56.3%)
Patients showing grimace while swallowing, with no discernible tongue-thrust	11 of 290 (3.7%)	46 of 497 (9.2%)
Patients showing a tongue-thrust while swallowing, with no grimace	3 of 290 (1%)	8 of 497 (4.6%)
Class II deep overbite cases showing abnormal swallowing	63 of 79 (79.7%)	98 of 156 (62.8%)
Open-bite cases showing abnormal swallowing	55 of 56 (98.2%)	78 of 84 (92.8%)
School pupils examined needing no orthodontic treatment	112 of 290 (38.6%)	No data
School pupils not needing orthodontic treatment and showing a normal swallow	92 of 112 (82.1%)	No data
Completely breast-fed children showing normal swallowing	2 of 4 (50%)	No data

DISCUSSION

Of the 497 orthodontic patients examined, 62.8 per cent were found to have abnormal swallowing habits. This finding agrees with findings in two other practices in the Southwest area, in which approximately 60 per cent of the patients were reported to be abnormal swallowers. The swallowing tests given the elementary school pupils in the normal-population sample revealed a surprisingly high proportion (56.9 per cent) of atypical swallowers.

It was quite a revelation for me to find that 68.9 per cent of the school children and 55.3 per cent of the orthodontic patients who showed deep overbites also demonstrated tongue-thrusts while swallowing. It is now apparent to me that many children with deep overbites open their jaws to swallow, thus allowing their tongues to protrude between the anterior teeth. This finding agrees with the findings of Straub[1] and other investigators.

A few children from both the school group and the orthodontic patients demonstrated a facial grimace with no accompanying tongue-thrust. This seems

to substantiate Strang's[10] belief that, in some cases at least, the muscles of facial expression (principally the buccinator and caninus muscles) take part in a normal swallow. Most of the children who showed a tongue-thrust with no accompanying grimace while swallowing had open-bites with short lips, and the tongue was free to move through the anterior teeth without touching the lips. Also, the majority of the children with posterior tongue-thrust showed no grimace.

The largest number of children whose abnormal swallowing was associated with a particular type of malocclusion was found in the Class II deep-overbite group. This is undoubtedly due to the prevalence of this problem, for a large percentage of the orthodontic cases fall into this category. This finding also emphasizes the fact that, contrary to popular orthodontic opinion, many patients with deep overbite show tongue-thrust while swallowing.

Although the actual number of open-bite cases in each group was not large in comparison to the number of deep overbite cases, the percentage of open-bites in which there was a tongue-thrust during swallowing (98 per cent and 92 per cent, respectively) was the highest recorded. These figures lend support to the premise that the tongue-thrust is not only responsible for the original open-bite condition but also may be the most potent factor in its recurrence after correction.

Of the school children examined, 38.6 per cent were judged to have no orthodontic problems. This represented a larger number of normal occlusions than I had anticipated. Salzmann,[24] however, reports a study of 119,000 St. Louis school children in 1934 which revealed that 49 per cent had no dentofacial abnormalities. Since the methods used in the St. Louis project are unreported and since the results of that study and the present one would undoubtedly have some tendency to reflect the opinions of the two examiners, a comparison of these two percentages may not be significant.

It is interesting to note that 82.1 per cent of the school children who appeared to have no need for orthodontic services also swallowed normally. This would seem to substantiate the theory that improper swallowing does disturb tooth position and normal dentofacial growth.

It is regrettable that only four completely breast-fed children were found in this study. The fact that two of these four children showed abnormal swallowing habits loses most of its significance in view of the small number involved. An accurate analysis of Straub's breast-feeding theory seems impossible unless interested persons could provide an adequate nation-wide sample by pooling their reports.

In my opinion, the findings of this study neither confirm nor deny Straub's theory, but they do emphasize the need for remedial instructions to the large number of children with abnormal swallowing habits. Of the three corrective methods mentioned earlier in this article, the speech therapy approach seems to be worthy of detailed description.

SPEECH THERAPY APPROACH TO THE PROBLEM OF PERVERTED SWALLOWING. Mr. Robert Achilles, in consultation with Dr. Martin Palmer, Director of the Wichita Institute of Logopedics, has outlined a program for correction of the

atypical swallowing habits of orthodontic patients. This approach differs from those used in California and Arizona in two main respects. The Wichita speech therapists believe, first, that practice in making certain sounds and exercises could be omitted from the training and, second, that during the child's first lesson his abnormal swallow with tongue-thrust could be completely replaced by a normal swallow without tongue-thrust. Schurter[26] concurs in this opinion. The only step-by-step process involved in the correction program is the gradual daily increase in time during which the patient pays strict attention to his swallowing.

Following is an outline of the program devised by the speech therapists:

First visit

A. Evaluation of the problem.
   1. The function of the posterior pharyngeal wall is noted.
   2. The functions of the pillars of the wall, fauces, and soft palate are noted.
   3. The action of the intrinsic and extrinsic muscles of the tongue is checked, leading to a recognition of the final force-vector mechanism of the tongue.
   4. The position of the mandible upon swallowing is checked to determine whether upper and lower teeth are in contact and to what extent.
   5. Muscles of facial expression involved in grimace are noted.

B. Explanation to the patient and his mother of the abnormal movements in this particular swallow.

C. Demonstration with a blunt instrument to show the spot where the tip of the tongue should press during swallowing.

D. Instruction in the actual swallow. The patient is asked to swallow carefully with the posterior teeth held tightly together, keeping the tip of his tongue in the proper position. The child should be shown with a mirror that his lips are sealed without tension.

E. Instructions for home practice. The patient is now instructed to begin breakfast the following morning by carefully chewing and swallowing a slice of dry, hard toast as instructed. All liquids, including soups, should be taken through a cellophane straw which the patient holds between the lips while sucking, swallowing, and breathing. This method of drinking should be followed whenever possible until the abnormal swallowing habit is corrected.

   If, in the parent's judgment, the patient does well in his concentrated effort at swallowing for five minutes, on the following morning he should swallow his entire breakfast in this way.

   As the patient demonstrates his ability to swallow correctly for longer periods, the evening meal should be included in the program of swallowing correction. At this time, chewy, fibrous foods, such as carrots, celery, cabbage, and tough meat, should be used. At certain times, when the mother can observe him, the patient should chew

sugarless gum for as long a period as he is willing to concentrate on swallowing the flow of saliva which the gum stimulates.

Second visit

The patient is checked by the therapist one week after the first visit. If the mother reports good progress and the therapist sees that the patient can now consciously swallow well, it is only a matter of practice until swallowing becomes a normal unconscious act, rather than a normal conscious one.

Third visit and subsequent visits

Monthly visits are made to the therapist until he is convinced that the patient swallows correctly and unconsciously.

SUMMARY

Recent literature has called attention to the relationship between tooth positions and abnormal tongue function during swallowing. Several orthodontists of my acquaintance tested their patients to ascertain the number of cases in which there was an abnormal swallowing habit. Each of these men expressed great surprise upon finding that 60 per cent or more of their patients had some form of abnormal movement of the tongue and/or facial muscles during swallowing. In some orthodontic practices 80 per cent of the patients are said to have atypical swallowing habits. An investigation of the orthodontic practice of Drs. Benton and Malone and myself revealed that 62.8 per cent of the patients examined showed a swallowing problem.

It was my belief that tests showing the percentage of children from a normal-population sample who had atypical swallowing patterns would add to our knowledge regarding the problem; therefore the subject was selected for investigation.

A review of the literature indicated that many competent investigators had provided valuable information regarding the normal swallowing act as well as abnormal swallowing patterns. This information includes detailed descriptions of the swallowing act, naming the muscles involved and explaining their function. Strang's textbook description of the swallowing act was used in this article, since it seemed to be the most complete and the least confusing.

The literature revealed several fine reports on work done with cinefluorography which confirm the sequence of movements in a normal swallow, as described by Strang. According to the reports on these studies, however, none of the subjects showed any abnormal tongue action. This seemed surprising to me, in view of the high percentage of the children observed who showed this abnormality.

The pupils of an elementary school were selected to serve as a normal-population sample. Although the age range of this group was lower than that of the orthodontic patients, I did not consider the discrepancy sufficient to preclude the comparison.

Both groups were given swallowing tests in the same manner, and all children were unaware of the purpose of the testing. Water from a rubber-bulb

syringe was squirted into the mouth of each child, and the child was asked to swallow. In some cases the swallowing speed necessitated repetition of the test to enable the operator to check the action and record the presence or absence of a tongue-thrust. Following use of the water, the operator retracted the lower lip with his forefinger, resting the thumb under the child's chin while the swallow was repeated. This afforded a better view, particularly of the posterior tongue-thrust, but it had the disadvantage of disturbing the circumoral musculature.

Anterior and posterior tongue-thrusts were tabulated on the same sheet (Fig. 1), but an asterisk was used to represent each *posterior* tongue-thrust. After the two swallowing checks had been made, the overbite was classified and recorded as "deep," "normal," or "open-bite." Next, the presence or absence of a facial grimace was recorded and the occlusion was recorded as Class I, II, or III.

While testing the school group, I also recorded my guess as to each pupil's need for orthodontic service at the present time, in the future, or not at all. Additional information was obtained and recorded concerning the fourteen children who, according to their mothers, had been completely breast-fed as infants.

As a result of these tests and comparisons, two observations seem significant:

1. In the school group, 56.9 per cent of the children had a tongue-thrust upon swallowing.
2. In the school group, 82.1 per cent of those with normal swallows also appeared to need *no* orthodontic service.

This certainly indicates a correlation between perverted swallowing and malocclusion.

The findings of this study definitely indicate a need for solving the problem of abnormal swallowing in the practice which my associates and I conduct.

The use of appliances to "fence" or "house" the tongue in proper position is reported to have been only partially successful. Findings concerning the use of hypnotherapy were based upon a study so limited in scope that it cannot be regarded as conclusive. Barritt[27] has reported that in approximately 80 per cent of the many orthodontic patients with whom he has worked in the Tucson area the abnormal swallowing has been corrected by exercises and speech therapy. Straub's work also indicates a high degree of success through these media. Because of these facts, I asked Mr. Robert Achilles of the Wichita Institute of Logopedics to develop a routine believed to be effective; his recommendations have been given in detail.

CONCLUSIONS

1. A comparison of the percentages of abnormal swallowing habits revealed that 62.8 per cent of the orthodontic patients examined demonstrated a swallowing abnormality, whereas 56.9 per cent of the elementary school pupils tested showed the same problem.

2. It was my opinion that improved tooth position resulting from orthodontic changes had eliminated the perverted swallowing in some of the orthodontic patients tested. This opinion is based on the fact that at the beginning

of treatment the tooth positions of some of these patients had shown evidence of a perverted swallowing habit; yet, with no specific therapy to correct swallowing habits, some of these patients demonstrated no tongue-thrust at the time of the survey. This group consisted of cases near completion of orthodontic treatment in which the overbite and overjet had been corrected.

3. Although it is difficult to draw a precise line between children who may need orthodontic treatment in the future and those who will not, I made an "educated guess" regarding such an eventuality as I tested each of the school children in the group. The result was that 38.6 per cent of these children were deemed to be free of any orthodontic problems, currently or in the future. Of this group, 82.1 per cent showed normal swallowing habits.

4. A large number of children with deep overbite were also found to have a tongue-thrust and facial grimace when swallowing.

5. Four children in the normal-population sample were found to have been completely breast-fed as infants. Of these four, two showed perverted swallowing and open-bites. Because of the small sample, I feel that this is inconclusive in so far as Straub's theory of bottle feeding is concerned.

I wish to express my sincere appreciation to my associates, J. Victor Benton and Robert F. Malone, for their encouragement and help in the preparation of this thesis. To our secretary, Miss Margaret McKillip, go my heartfelt thanks for the many hours of editing, typing, and proofreading that were needed to complete the project. Dr. L. H. Shepoiser, Superintendent of Wichita Schools, Miss Elsie Rathbun, Director of School Nurses, and Miss Nan Wade, Principal of Kos Harris Elementary School, were all most cooperative in arranging for swallowing tests of the pupils of Kos Harris School. To my wife and children may I express my thanks for the patience, love, and understanding that made this work possible.

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The relationship between occlusion and periodontal status

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ACHIEVING the ideal in tooth form, tissue contour, and facial harmony is the ultimate goal of treatment procedures in the various branches of dentistry. The implication is clear that ideal structure is an important prerequisite to the maintenance of optimum dental health. From a logical standpoint, it would seem that the functional influences exerted by a normal occlusion would have the best possible physiologic influence on the surrounding tissues.

The observations of an individual clinician, however, may not happen to confirm this generalization. A few adult patients with severe malocclusion and no sign of periodontal disturbance may suggest that occlusion is of relatively little importance to the condition of the surrounding tissues. The same implication arises from cases in which patients have excellent occlusion and severe periodontal disease.

Few would question the undoubtedly harmful effect on the periodontium of specific local tooth irregularities which will traumatize either the opposing teeth or the surrounding tissues. These conditions are easily recognized and must be corrected in the treatment of local traumatic periodontal problems. However, such observations do not necessarily lead to the conclusion that a patient in need of orthodontic treatment will be more susceptible to periodontal disease than a patient whose teeth are in good occlusion.

Because of the clinical importance of the relationship between occlusion and periodontal status, a survey was undertaken to measure the incidence of these variables in a population group. While there are many factors which will influence both of the entities in question, appropriate statistical methods were

Portions of this study were conducted at United States Public Health Service Facilities in Alameda, California, and in Bethesda, Maryland.

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applied to determine whether the distribution of malocclusion and periodontal disease was due to more than chance.

INDEX OF OCCLUSION

Translating the observation of clinical conditions into terms which can be handled statistically is a complex and controversial procedure. An index must be simple, reproducible, and objective.

Several serious efforts have been made to develop a satisfactory method of assessing malocclusion in large population groups. Massler and Frankel[1] provided an excellent historical review of the problem and proposed an index based on the unit of occlusion. A score for each individual is obtained on the basis of the number of malocclueded teeth observed. However, attempts to apply this method have been hampered by the difficulty of judging the conformity of each tooth to its proper position in all planes of space and by the resulting lack of consistency in scoring.

More recently, Van Kirk and Pennell[2] proposed a more detailed scoring method for evaluating the malalignment of teeth in each arch with exact criteria for recording the degree of severity. Because this examination is made with the mouth open and the alignment is evaluated only from the occlusal aspect, scoring is easier and probably more consistent. This method appears to measure malocclusion indirectly, though, since the score is not affected in any way by the relationship of the upper and the lower teeth in occlusion.

Since we were particularly interested in the orthodontic implications of this survey, we used an index of occlusion which was developed at the National Institute of Dental Research in 1957. The Occlusion Feature Index (OFI) is based on four primary features of occlusion which are of importance in an orthodontic examination. A value is assigned each of these features according to the following objective criteria:

1. Lower anterior arch crowding in the canine-to-canine area
   0. None
   1. Crowding of lower anterior teeth equivalent to one-half the width of the lower right central incisor
   2. Crowding the width of one central incisor
   3. Crowding exceeding the width of one central incisor

2. Cuspal interdigitation, observed in occlusion looking at the right premolar-to-molar area from the buccal aspect
   0. Cusp-to-groove relationship
   1. Between cusp and groove
   2. Cusp-to-cusp

3. Vertical overbite, measured by that portion of the lower incisors covered by upper central incisors in occlusion
   0. Incisal third of lower incisors
   1. Middle third of lower incisors
   2. Gingival third of lower incisors

4. Horizontal overjet, measured in occlusion with a small ruler from labial surface of upper incisors to labial surface of lower incisors
   0. 0 to 1.5 mm.
   1. 1.5 to 3 mm.
   2. 3 mm. and over

The number for each of the four categories is recorded, and a total score may be obtained by adding them together. The possible range is from 0 to 9.

A preliminary test of the OFI scoring procedure was performed on a group of 152 teen-age boys in the Washington, D. C., area. This examination was performed by two dentists working separately; at the same time, an experienced orthodontist classified the malocclusions subjectively according to severity. An

Table I. *Comparative OFI scores by two examiners*

Examiner	*No. of examinations*	*Average score*	*Range of scores*			
			0-1	*2-3*	*4-5*	*6-9*
A	152	3.90	18	55	46	33
B	152	3.64	23	58	45	26
Average	—	3.77	20.5	56.5	45.5	29.5

evaluation of the consistency of the index as used by different investigators and its relationship to a conventional orthodontic examination was made possible. As shown in Table I, the index values obtained by the two examiners were in close agreement.

A detailed comparison of the OFI score of each patient as given by each examiner is shown in Fig. 1. The area between the dotted lines shows the cases in which agreement was perfect; these cases made up 34 per cent of the total. The area between the solid lines shows the cases in which scores differed by only 1 point, plus or minus. This represented 77 per cent of the total cases, showing a satisfactory lack of individual variation. These findings suggest that the examination procedure is not influenced appreciably by subjective variation and could be expected to give reasonably consistent results when employed by any examiner trained in its use.

Orthodontic ratings of each occlusion were made by the orthodontist working separately and with no knowledge of scoring procedures used in the OFI classification. The criteria for classification were as follows:

Slight—No need for orthodontic treatment
Mild—Some variation from ideal occlusion but not sufficient to need treatment
Moderate—Orthodontic treatment indicated and would be beneficial
Severe—Treatment essential

The subjective nature of this "need-for-treatment" rating does not lend itself to larger population groups, but the close relationship to the OFI scores is apparent.

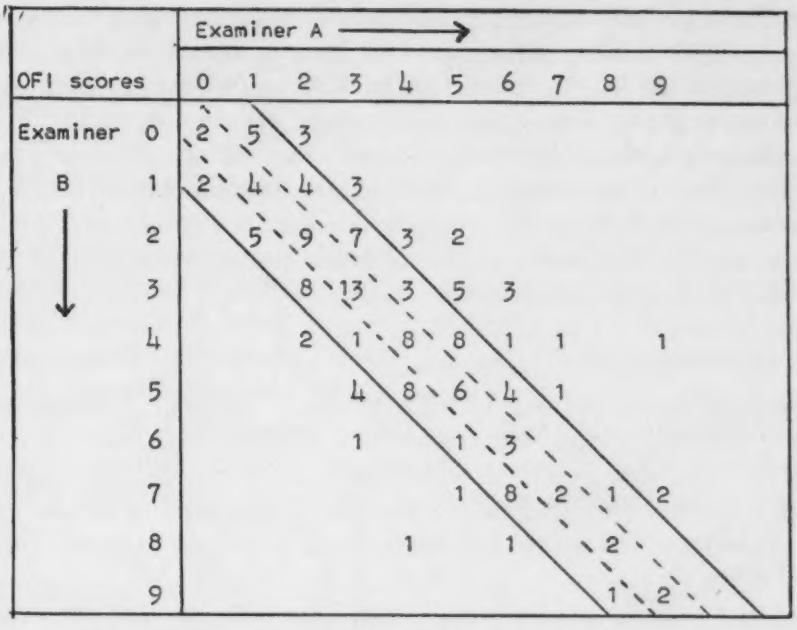

Fig. 1. Distribution of OFI scores given by two examiners.

Of the eighteen malocclusions scored as 0 or 1, seven were rated slight and none were rated severe. At the other extreme of the score range, of the thirty-three malocclusions scored as 6 to 9, none were rated slight, eighteen were rated moderate, and eight were rated severe.

Looking at the scores another way, we find that the malocclusions rated slight had an average score of 2.0, the mild ones averaged 3.5, the moderate ones averaged 4.3, and those rated severe had an average score of 7.2. It seems justifiable to say, then, that these four simple observations, which depend on easily defined criteria, yield a numerical score which will agree very closely with the findings of an orthodontic examination.

A description of another index designed to record deviations from normal occlusion has subsequently been published by Draker.[3] This index (the HLD Index) is very similar to the OFI, but, because it was designed for the specific purpose of designating cases involving physical handicaps, certain severe conditions which may occur in a small percentage of the population are given special

Table II. *Comparison of OFI scores with subjective orthodontic examination*

Range of malocclusion score	*Number*	*Orthodontic rating*			
		Slight	*Mild*	*Moderate*	*Severe*
0-1	18	7	6	5	0
2-3	55	15	23	16	1
4-5	46	2	21	20	3
6-9	33	0	7	18	8
Average score	152	2.0	3.5	4.3	7.2

emphasis. These conditions (cleft palate, severe traumatic deviation, mandibular protrusion, and open-bite) must be noted in a screening program, but their introduction into the scoring procedure on a correlation study such as the one reported here would introduce many uncertainties.

The other significant difference between the OFI and Draker's procedure lies in the method of obtaining an anterior crowding measure. The HLD index uses a measurement between the most deviated anterior teeth in a labiolingual direction to give an indication of the condition noted in the OFI as lower anterior arch crowding.

INDEX OF PERIODONTAL STATUS

We used the index devised by Russell[4] of the National Institute of Dental Research to establish the periodontal status of each patient. This index has been described in detail and has been widely used in dental field studies. The examination is clinical only and can be completed in a minute or less by an experienced examiner. The supporting tissue around each tooth is rated according to the following scale:

0. *Negative*—There is neither overt inflammation in the investing tissues nor loss of function due to destruction of supporting tissues
1. *Mild gingivitis*—There is an overt area of inflammation in the free gingiva, but this area does not circumscribe the tooth
2. *Gingivitis*—Inflammation completely circumscribes the tooth, but there is no apparent break in the epithelial attachment
6. *Gingivitis with pocket formation*—The epithelial attachment has been broken and there is a pocket (not merely a deepened gingival crevice due to swelling in the free gingival tissue); there is no interference with normal masticatory function; the tooth has not drifted and is firm in its socket
8. *Advanced destruction with loss of masticatory function*—The tooth may be loose, it may have drifted, it may sound dull on percussion with a metallic instrument, and it may be depressed in its socket

The total values are then added up and divided by the number of teeth examined, giving an average score for each individual. This score represents the amount of periodontal disease which can be observed.

MATERIAL AND PROCEDURE

The malocclusion and periodontal scoring procedures were performed on a sample of 908 male subjects between the ages of 17 and 26 years. The subjects were 90 per cent Caucasians. The survey was carried out in conjunction with the original dental examination of recruits at the United States Coast Guard Base,* Alameda, California, by a single examiner.

A mouth mirror, compressed air, and a dental operating light were available for each examination, which required no more than one to one and one-half

*Dr. J. C. Heckel, whose cooperation made this study possible, is the Chief Dental Officer.

minutes. The cuspal interdigitation and periodontal status were recorded only on the right side, with a minimum of twelve teeth present in the right upper and lower quadrants, collectively, in all patients included in the survey.

The size of the sample (908), the small age spread, and the lack of sex difference are definite contributing factors to the meaningful evaluation of the data. It would be scarcely feasible for a single examiner to carry out measurements and subsequently handle the data on a significantly larger number of persons. Having all measurements made by a single examiner assures a degree of consistency in method, which is another advantage to this sort of data. By this same token, it also introduces a note of difficulty in the interpretation of the findings because of the degree of correlation which may be unconsciously introduced by the examiner between the measurement of occlusion and of periodontal disease. Since each of the measurements was made only with carefully defined and, as far as possible, objective criteria, it does not seem likely that this factor introduced a sufficiently large degree of error to seriously affect the value of the findings.

FINDINGS

As the first method of evaluating the data, the average periodontal scores were arranged according to the malocclusion scores given each subject.

The ordered relationship between occlusion and periodontal scores is impressive. Each category of increasing malocclusion score received a progressively higher average periodontal score. In other words, in these 908 cases, as the occlusion deviated farther from the normal, an increasing amount of periodontal disease was found.

This finding suggests that there is some degree of correlation between occlusion and periodontal status. By applying the correlation coefficient $r = \frac{Exy}{\sqrt{Ex^2Ey^2}}$ to the data and calculating the degree of relationship for the entire sample, we found "r" to be + .24, which indicates a positive small but significant degree of correlation. The degree of statistical significance is such that the probability of r = + .24 occurring by chance alone in a sample of 908 cases is virtually nonexistent.

Since the OFI score is obtained by the summation of four important features of occlusion, it is possible to study each of these features separately as it

Table IV. *Periodontal scores received grouped by rating of occlusion features*

Occlusion feature rating	*Lower anterior crowding*		*Cuspid interdigitation*		*Overbite*		*Horizontal overjet*	
	Number	*Periodontal score*	*Number*	*Periodontal score*	*Number*	*Periodontal score*	*Number*	*Periodontal score*
0	669	0.42	586	0.41	603	0.39	632	0.42
1	201	0.59	275	0.54	227	0.53	136	0.53
2	37	0.61	47	0.68	78	0.64	140	0.58

relates to the periodontal index. In Table IV the average periodontal index scores received are related to the number assigned on the basis of the various features of occlusion.

Table IV shows that, in addition to the over-all relationship between occlusion and periodontal condition shown in Fig. 2, a similar relationship was found between each of the occlusion features evaluated separately and the periodontal condition.

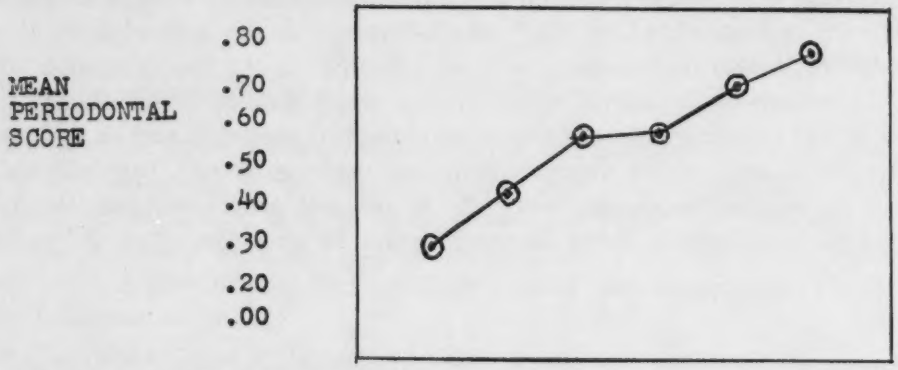

Fig. 2. Comparison of malocclusion (OFI) and periodontal scores in 908 examinations.

DISCUSSION

The nature of periodontal disease is such that in this age group (17 to 26 years) a relatively low index of disease would be expected. The mean periodontal score for the entire group was 0.48, which certainly bears out this premise. This score indicates that, on the average, there was no overt sign of periodontal disease around half of the teeth examined and nothing more serious than a mild gingivitis around the other half. On this basis, it might be expected that, with such a low prevalence of periodontal disease to work with, any relationship to occlusion would be very difficult to establish. As was noted in Fig. 2, however, the cases in which there was an OFI score of 0 had an average periodontal score of 0.29, while those in which the OFI score was 5 or more had an average periodontal score of 0.79—well over twice the severity of the preceding group.

In the evaluation of the significance of $r = +.24$, Russell's comments are significant:

> Let us assume that a phenomenon, A, is associated with a variable, X, and to simplify the illustration, let us assume that the association is one of cause and effect. If X is a nonspecific response which can be elicited by any one of a series of causes, B, C, D—variables sometimes present simultaneously with A, *but independent of A*—then it is obviously absurd to expect all of the variation in X to be explained by the influence of A alone. Dropping the assumption of cause and effect, this is the situation when malocclusion is associated with gingivitis; gingivitis can result from any of a variety of known causes which are independent of occlusion. Now, $r = +.24$ is a statement of the degree of accuracy with which the gingival status of any one individual can be predicted, once his occlusal score is known. On this

basis, OFI explains little of the individual variation, which is responsive in part to causes not included in the simple equation used here. But these causes, being independent of occlusion, tend to occur randomly in individuals scored over the whole range of OFI scores. Hence, they tend to balance out when groups, rather than individuals, are considered.

It is appropriate, then, to study grouped data such as those in [Fig. 2]. This graph shows that, on the whole, mean periodontal scores rise quite consistently and predictably with the rise of OFI scores and one concludes intuitively that, other things being equal, the two phenomena as scored in this manner are closely related.

The significance of occlusion to periodontal condition in this relatively early stage leads to speculation as to just what the situation might be in older age groups. It is possible that with the presence of a greater amount, and hence a more measurable quantity, of periodontal disease the correlation might be even stronger. On the other hand, it might be found that the correlation was weaker, indicating that influences other than occlusion had become more dominant in the progress of periodontal disease. In either case, the clinical significance of this relationship is great enough that additional studies on older age groups should be carried out to increase our information in this area.

The information given in Table IV is of interest not only because it shows the significant relationship of each of the occlusion features to the periodontal score but also because it shows the close relationship of the various occlusion features to each other. The very nature of a malocclusion is such that a deviation in one of the measurements creates a strong tendency toward some discrepancy in the other features. In the general run of malocclusions, a person with crowded lower anterior teeth will tend to have a deep overbite, a person with deep overbite will tend to have a large horizontal overjet, and a person with an excessive overjet will tend to have faulty posterior interdigitation. It might be interesting to run a multiple correlation on all of the occlusion features and on the periodontal score, but such a procedure is beyond the scope of this study.

The statistical confirmation of the existence of a significant link between periodontal status and occlusion is reassuring to the orthodontist who has been engaged in correcting malocclusion. Although few orthodontists would state that maintenance of periodontal health was the most important reason for a patient's having orthodontic treatment, even fewer would say that it had no importance whatsoever. Ideal alignment and correct interdigitation of anterior and posterior teeth have been the goals of orthodontic treatment on the basis of empiricism and esthetic consideration more than on the basis of dental health maintenance.

The demonstration of statistical correlation, no matter how strong, does not prove the existence of a cause-and-effect relationship between the factors involved. A definite correlation between periodontal status and occlusion has been shown, however, and several possible explanations for this relationship should be explored.

One possibility would be that both are caused by the same set of factors. Yet the main causes of malocclusion do not coincide with the causes of periodontal disease. A search for common etiological factors would have to be limited

to such vague generalities as an "unfavorable environment" or "genetic predisposition."

The hypothesis that periodontal disease is a causative factor in malocclusion would be even less tenable. Malocclusion is a deviation from ideal dental morphology which is usually present in its most severe form when the last permanent tooth has erupted. Its development is generally inherent in the dental and facial patterns of the patient. Periodontal disease, by contrast, is a slowly developing condition which seldom presents a picture of serious disease until the patient has reached full maturity. The severity of untreated periodontal disease almost always increases through the years. In other words, it is much more likely that malocclusion, which reaches full severity first, would tend to be the causative agent.

There is also clinical evidence to support this hypothesis. Malocclusion has been linked to periodontal disturbance because of direct trauma to gingival tissue by food particles. The abnormal gingival architecture around severely malaligned teeth may expose the gingiva to abrasion and irritation not compatible with this type of tissue. Food impaction and lack of natural hygiene contribute further to the problem. Traumatic occlusion has been cited as a specific cause of periodontal destruction.

With these considerations in mind, the observed correlation between occlusion and periodontal scores may be due to a cause-and-effect relationship. Specifically, malocclusion may be an important causative factor in periodontal disease.

SUMMARY

1. The Occlusion Feature Index (OFI) described here appears to be a workable, meaningful means of recording malocclusion in population studies.

2. OFI scores on 152 subjects did not differ significantly when obtained by two examiners, and they showed close correlation with a separate need-for-orthodontic-treatment rating.

3. OFI and periodontal status scores were run on a group of 908 male subjects and a significant correlation was shown, leading to the hypothesis that malocclusion may be important in the etiology of early periodontal disease.

4. On the basis of these findings, each of the following features of occlusion showed a significant relationship to periodontal status: (a) vertical incisor overbite, (b) posterior cuspal interdigitation, (c) lower anterior crowding, and (d) horizontal incisor overjet.

The authors wish to express their appreciation for the guidance and encouragement of Drs. Wendell L. Wylie and Albert L. Russell.

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President's page

MOST of the constituent societies of the American Association of Orthodontists will have their annual meetings within the next few months. The end of the vacation periods and the beginning of the fall school sessions bring additional work loads to orthodontic practices. We are entering a very active period in the orthodontist's year.

However, the members of Program and Local Arrangements Committees for the 1962 annual meeting of the American Association of Orthodontists to be held in Los Angeles next April 28 to May 3 are probably the busiest orthodontists in the nation. They are preparing a fine annual meeting for you. It is not too early to begin planning to attend this fifty-eighth annual session of the A. A. O. If you have any doubt whatever about the desirability of attending, let me give you two good reasons why you should banish such doubts from your mind immediately.

The first and most important reason is the nature of the program to be presented. This program is designed to provide tangible benefits to your clinical practice. Essays and panels have been chosen which will help you meet the most urgent and challenging problem in our specialty. The detailed explanation for such a strong statement must be reserved for later presentation. However, this much can be stated here: It has become evident to all of us that the orthodontic problem begins very early in the development of the dentition. The biodynamics of function and the influences of physiologic pressures on dentofacial development are very important to the success of our therapies. There are great advantages to be gained from early establishment of optimum function of the orodental complex. It is planned for our program to place emphasis on this phase of our treatment. Presently advocated therapeutic methods of choice will be discussed thoroughly by a panel of our most experienced members. The benefits to your practice accruing from this program will be most substantial.

The second reason for making positive plans now to attend the 1962 meeting in Los Angeles is Southern California itself. During the meeting, delightful diversions will be made available for group enjoyment. Before and after the meeting the many enjoyable vacation attractions of city, desert, mountains, and ocean are immediately available.

For those who know and appreciate the unmatched pleasures afforded by Hawaii, we have arranged a postconvention excursion to Honolulu to attend

the May 6 to 8 meeting of the Hawaii Orthodontic Society. This meeting will be of particular interest to our members, as it will carry on in further detail the subjects dealt with in Los Angeles. A joyful week in the island paradise will follow. If you have not yet visited the beautiful Hawaiian Islands, then this is the time to make a dream come true. For those who have been there before and return as "Kamaainas" (old-timers), it is a time to renew old loves and adventures. Arrangements have been completed for a delightful stay at the beautiful Hilton Hawaiian Village Hotel complete with optional tours and events for both men and ladies which will make the meeting one of fun and interest to all of us. Details of this postconvention meeting and holiday trip will be presented to members in the near future. We hope that you will take advantage of this unusual opportunity.

In Los Angeles the hotel facilities are excellent. They are also ample to accommodate an attendance far in excess of any our Association has experienced before. As is always the case, however, the choice accommodations go to those who make up their minds first.

If you wish to add to your professional knowledge and, at the same time, partake of a wonderfully enjoyable holiday in Southern California and Hawaii, make your plans now to attend the fifty-eighth annual meeting of the A. A. O.

Dallas R. McCauley, President,
American Association of Orthodontists.

IN MEMORIAM

Brewer E. Phillips

BREWER E. PHILLIPS, orthodontist and prominent Mason, died in a Salt Lake City hospital on March 8, 1961.

Dr. Phillips was born in Cassadaga, New York, on Aug. 15, 1893, the son of Edson Wallace and Laura Smith Phillips. He graduated from Baylor University Dental School in 1919 and practiced in Globe, Arizona, from 1919 to 1933, when he moved to Salt Lake City, Utah. He was a member of the Salt Lake City Dental Society, the Utah State Dental Association, the American Dental Association, the Pacific Coast Society of Orthodontists, and the American Association of Orthodontists.

He was a past master of the White Mountain Lodge No. 3, Globe, Arizona, Free and Accepted Masons, a 32nd degree Mason in the York Rite of Free Masons in Salt Lake City, and a member of the El Kalah Shrine Band. He was also an active member of the First Presbyterian Church in Salt Lake City.

Dr. Phillips is survived by his wife, the former Algie May Henry; a son, James, of Sioux City, Iowa; two daughters, Mrs. Marguerite Brown of Jonesboro, Arkansas, and Mrs. James Anderson of Whittier, California. Ten grandchildren and a sister also survive.

I. L. Marcus.

DEPARTMENT OF ABSTRACTS AND REVIEWS

Edited by DR. J. A. SALZMANN, *New York City*

All communications concerning further information about abstracted material and the acceptance of articles or books for consideration in this department should be addressed to Dr. J. A. Salzmann, 654 Madison Avenue, New York City.

Abstracts of papers presented before the Research Section of the American Association of Orthodontists, Washington, D. C., April 26, 1960

A Cephalometric Study of the Growth of the Nose

By John F. Manera and J. Daniel Subtelny, Eastman Dental Dispensary, Rochester, New York.

The purpose of this study was to contribute information pertinent to the growth of the skeletal and soft-tissue components of the nose, together with concomitant changes relative to the facial profile.

Tracings of serial cephalometric radiograms obtained on thirty subjects from 3 months to 18 years of age were studied. These tracings were part of a study previously conducted on radiographs obtained from the files of the Bolton Study of the Face of the Growing Child at Western Reserve University. Measurements and averages were obtained for different age intervals and grouped according to sex to indicate general tendencies which could be confirmed by individual series.

Linear measurements from nasion to the tip of the nasal bone and the tip of the cartilaginous aspect of the nose indicate that both are increasing in length with progression in time. The averaged measurements reveal a rather consistent increase in the downward and forward growth of the nose from infancy to early adulthood. In both sexes and at all age levels, the nasal bone seemed to maintain a proportional relationship, in length, to the total length of the nose as measured from nasion to the nose tip. Nasal bone length was approximately 40 to 45 per cent of the total length of the nose. Further dimensions of the nose were obtained by projecting lines from the tip of the nose and from subnasale at a perpendicular to the facial plane (Fig. 1). Linear measurements along the horizontal lines provided data on the anteroposterior depth of the nose. Measurements along the facial plane from nasion to the points of intersection of horizontal lines provided data on the vertical height of the nose. In both sexes, the increase in vertical dimension was much greater than the increase in anteroposterior dimension with growth. Angular measurements of the relationship of the nasal bone and the cartilaginous aspect

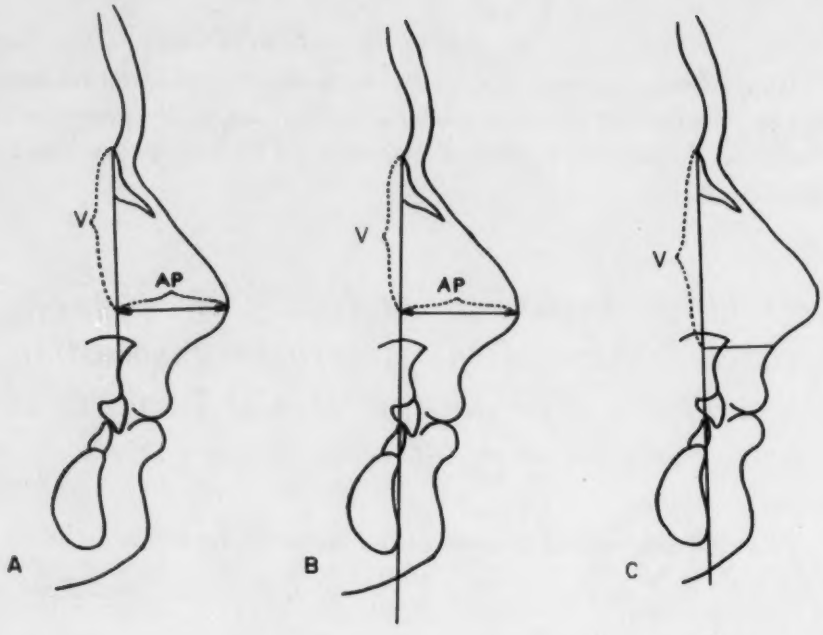

Fig. 1.

of the nose with a cranial base line (BaN) indicate that both are progressively attaining a more forward position with increased age. Changes in the prominence of the nose relative to the face were studied by measuring the angular changes between the skeletal and cartilaginous aspects of the nose with the facial plane. The nasal bone showed considerable increase in angulation relative to the facial plane, whereas the cartilaginous aspect, although showing

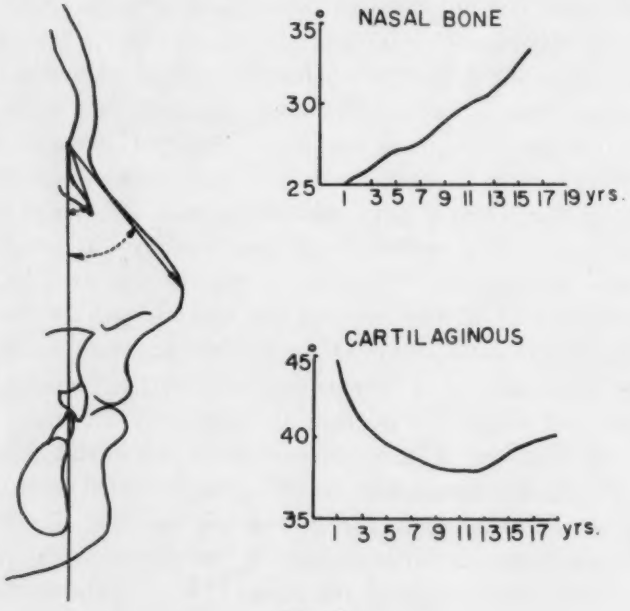

Fig. 2.

increase in angulation during the later stages of development, seemed comparatively small in angular increments (Fig. 2).

Growth of the nose progresses from the early stages to the later stages of development in a steady and consistent manner by growth of its skeletal and soft-tissue components in a downward and forward direction. Compositely, this tends to produce an increase in nose prominence relative to the facial profile.

Relationship Between Mesiodistal Crown Diameters in the Deciduous and Permanent Lateral Teeth

By Lennart Lysell. Acta odont. scandinav. **18**: *November, 1960.*

The mesiodistal diameters of the canines and first and second molars (first and second premolars) were measured on casts of a series of fifty boys and fifty girls taken at the age of 3 to 5 years and again at age 14. The differences in diameter of the deciduous teeth and the corresponding permanent teeth were calculated to an accuracy of 0.1 mm. The differences in combined tooth diameter in the lateral segments of the two dentitions were also calculated. Values of 1 and 2 mm. were obtained for the upper and lower jaws, respectively, the permanent teeth being the smaller.

The coefficients of correlation between the deciduous teeth and the corresponding permanent teeth were between r = +0.20 and +0.53. There is also a fairly marked correlation between the right and left sides with respect to the difference in combined diameters of the deciduous and permanent lateral teeth (r = +0.56 to +0.76) and between the upper and lower jaws (r = +0.49 to +0.65).

The relationship between the mesiodistal crown diameters in the deciduous and permanent dentitions is only one of the questions bearing on the space conditions in the dental arches. Other factors of at least equal importance are the extent and direction of the growth of the jaws, the size of the teeth, and the movement of teeth adjacent to gaps. These problems will be dealt with when a larger series of cases is available.

Interrelations in Dental Development. I. Interrelationships Within the Dentition

By Stanley M. Garn, Arthur B. Lewis, and Demarest L. Polacheck. J. D. Res. **39**: *1049-1055, September-October, 1960.*

This investigation was based on the ages at which specified stages of tooth calcification and tooth eruption appeared, as ascertained from over 3,000 serial, longitudinal oblique-jaw radiographs, supplemented by lateral headplates of 259 white Ohio-born participants in the Fels Longitudinal Program.

Data on three calcification stages (beginning calcification, crown completion, and apical closure) and two stages of tooth eruption (alveolar eruption and attainment of the occlusal level) were converted into normalized T-scores and punched on standard 80-column IBM cards. Intercorrelations were then obtained for each pair of variables representing different stages of development of

premolars and molars. The majority of the correlations were calculated with the aid of an electronic computer, and the remainder were computed with a desk calculator.

Developmental events within the dentition prove to be moderately intercorrelated during the growing period in both sexes. This association holds true for successive developmental stages involving initial calcification, crown development, and apical closure. It is true for tooth movement and for the relationship between tooth formation and tooth movement. Moreover, although the magnitude of the intercorrelations decreases with the advancing time span between the developmental events involved, there is predictability over a full thirteen-year period.

One of the purposes of the present study was to determine whether, from a single oblique-jaw plate, one could predict the future dental status of a person or generalize about the probable course of dental development of a group. As to the former, caution is indicated, except for short-term predictions involving a few years at most. Stature at the age of 18 is far better predicted by stature at age 2 than dental status at 13 is predicted by dental status at 11. On the other hand, especially for groups, some degree of predictability does exist. Using specific events as a measure of comparison, such as the number of hand-wrist ossification centers present at a given age, predictability within the dentition is of the same order of magnitude as predictability in the hand.

It follows, then, that marked developmental acceleration or retardation in the dentition at an early age is predictive of acceleration or retardation at a later age. As applied to the two morphologic classes considered here, and especially to particular teeth, predictability is necessarily higher. It would be erroneous, however, to assume that uniform rates of development characterize the dentition as a whole; early moderate advancement may be associated in some persons with later moderate retardation.

Abstracts of papers presented before the Middle Atlantic Society of Orthodontists, Atlantic City, N. J., Oct. 10, 1960

Early Second Permanent Molar Extractions in Orthodontics

By Holly Halderson, D.D.S., Toronto, Ontario.

Malocclusions caused by insufficient bone and lack of dental arch can hardly be corrected without the removal of some permanent teeth.

In extracting four premolars, the orthodontist may face two serious problems: (1) the mouth of a mature patient may have a flat appearance; (2) it may be difficult to maintain the six anterior teeth in contact or the appearance of small diastemas between these teeth may be difficult to avoid.

Frequently, extraction of permanent molars eliminates these two problems and is a desirable procedure in deep overbite cases. However, the third molars should be adequate in size and shape before second permanent molars are extracted. Caution should be exercised in this late extraction, as a tipping-forward of the mandibular third molars frequently results. Late extraction of the maxillary second molars does not have this tipping effect.

Extraction of all four second molars is not necessary when there is ideal occlusion on one side with loss of arch length on the other or when the patient has an ideal mandibular dental arch with loss of arch length in the maxilla.

Second permanent molars can be extracted ideally when little or no root development of the third molars is revealed in an x-ray survey.

No failures were experienced in extractions of second molars in the age range of 11 years 11 months to 18 years. In every case the third molars erupted into good occlusion. This is very gratifying to the orthodontist, since he has no worries about third molars causing a relapse of some of his treated nonextraction cases. And, of course, the patient has no worry about impacted wisdom teeth.

73 Warren Rd.

Routine Use of Minute Forces

By Holly Halderson, D.D.S., Toronto, Ontario.

It seems to be better to work with forces not greater than the pressures in the blood capillaries to move a tooth. The rate of tooth movement is determined largely by the speed with which the periodontal membrane can re-establish circulation in pressure areas. A force interfering with circulation will, of necessity, cause tissue pathosis. Our task as orthodontists is to minimize that pathosis. The accurate measurement of the forces inherent in arch wires and springs is made by an electronically controlled strain gauge which is sensitive to force variations of 0.01 gram. It is important to note the force exerted by the 0.012 and 0.014 inch wires in making auxiliary springs, the diameter of the spring wire being varied. The 0.014 inch wire is seldom deflected a full 1 mm. against incisors, although the deflection is up to 2 mm. against molar teeth. Force application ranges from 9 to 14 grams on all teeth except molars and from 20 to 40 grams on molars.

By varying the length of the spring we affect the amount of the weight against the tooth, and by lengthening the lever arm we produce a gentler force. The result is that clinicians favor recurve springs, high vertical loops, and long coil springs.

This study also examines the plain arch wire with no loops added. It was discovered, by carefully measuring the amount of force required to move the wire to the bracket, that the clinician cannot make adjustments in a force range as low as the capillary blood pressure. These appliances are not therefore condemned, but care must be taken that the high force is less than the width of the periodontal membranes and that it is not reapplied before repair to the tissue has been re-established. A suggestion is offered for the purpose of classification, namely, "minute forces" (25 grams per square centimeter) less than capillary blood pressure and "light forces" (30 to 115 grams).

In the opinion of the writer, the multiband mechanism with multiple loops on light arch wires is the most important advance made in the application of light forces in the multiband technique.

NEWS AND NOTES

American Association of Orthodontists 1962 Research Meeting

The research meeting of the American Association of Orthodontists will be a program consisting of a series of ten-minute research reports which shall be presented orally or read by title only. All persons engaged in research in orthodontics or cognate fields are invited to participate in this program, which will be held April 29 to May 3, 1962, in Los Angeles, California.

Each participant is asked to prepare a 300 word abstract of his research project for publication in the AMERICAN JOURNAL OF ORTHODONTICS and a 25 word summary of the work to be included in the program for the meeting. Abstracts for publication, summaries for the program, and the ten-minute oral presentations to be given at the meeting should be carefully prepared in order that an adequate description of the import of the work may be presented.

Forms for use in submitting the titles, 300 word abstracts, and 25 word summaries of research projects will be sent to the orthodontic department of each dental school and to any individual requesting one.

In order to be included in the program of the research meeting in Los Angeles, titles, abstracts, and summaries of research projects must be mailed not later than Jan. 1, 1962, to Dr. Richard A. Riedel, Department of Orthodontics, University of Washington, School of Dentistry, Seattle 5, Washington.

Faustin N. Weber, Chairman, Research Committee
American Association of Orthodontists
Professor and Head, Department of Orthodontics
University of Tennessee
847 Monroe Ave.
Memphis 3, Tennessee.

American Association of Orthodontists 1962 Milo Hellman Prize Essay Contest

ELIGIBILITY. Any member of the American Association of Orthodontists and any person affiliated with a recognized institution in the field of dentistry or associated with it as a teacher, researcher, undergraduate, or graduate student shall be eligible to enter the competition.

CHARACTER OF ESSAY. Each essay submitted must represent an original investigation and contain some new significant material of value to the art and science of orthodontics, and it must be the contestant's first research orthodontic publication.

AWARDS. Two Hellman Awards are offered—one for the best work presented (the experienced as well as the new researcher is eligible for this award) and one for a researcher

Trademarks of Southern California—palm trees, orange groves, and snow-capped mountain peaks, a combination that can be seen nowhere in North America but in Southern California with its varied geography and mild winter, dry subtropical climate. This beautifully scenic roadway faces 10,630 foot Mt. San Bernardino, looming over the country of rich orange groves surrounding the citrus cities of San Bernardino and Redlands. (Courtesy All-Year Club of Southern California.)

presenting his initial essay. A cash prize of $500.00 is offered for the essay judged to be the best submitted from those papers that represent the contestants' first research essay. However, the Committee reserves the right to omit either or both awards if, in its judgment, none of the essays is considered worthy of an award. Honorable mention will be awarded to the four authors whose essays are ranked immediately below the prize essay. Each of the honorable mention awards carries a $100.00 cash prize. As in the case of the prize essay, the Committee may, at its discretion, omit any or all honorable mention awards if the entries submitted are not worthy of them. The Hellman Award essays and the first two essays meriting honorable mention will become the property of the American Association of Orthodontists and will be published. All other essays will be returned.

SPECIFICATIONS. All essays must be in English, typewritten on 8½ by 11 inch white paper, double spaced, with at least 1 inch margins. Each sheet must be numbered and bound or assembled with paper fasteners in a "brief cover" for easy handling. The title of the essay should appear on the cover. Five complete copies of each essay, including all illustrations, tables, and bibliography, must be submitted. The name and address of the author must not

That first look at the Pacific! For millions of Southern California visitors, this thrilling experience has occurred atop the Palisades sea cliff park at Santa Monica. (Courtesy All-Year Club of Southern California.)

appear in the essay. For purposes of identification, the title of the essay and the author's name, together with a brief biographical sketch which sets forth his or her dental and/or orthodontic training, present activity, and status (practitioner, teacher, student, research worker, etc.), should be typed on a separate sheet of paper and enclosed in a plain sealed envelope. The title of the essay should appear on the outside of this sealed envelope.

PRESENTATION. The author of the winning essay will be invited to present it at the meeting of the American Association of Orthodontists in Los Angeles, California, April 29 to May 3, 1962.

JUDGES. The entries will be judged by the Research Committee of the American Association of Orthodontists.

FINAL SUBMISSION DATE. No essay will be considered for this competition unless it is postmarked on or before Jan. 1, 1962, and five copies of the essay sent to Dr. Albert P. Westfall, University of Texas Dental Branch, Department of Orthodontics, Houston 25, Texas.

Faustin N. Weber, Chairman, Research Committee
American Association of Orthodontists
Professor and Head, Department of Orthodontics
University of Tennessee
847 Monroe Ave.
Memphis 3, Tennessee.

American Board of Orthodontics

The next meeting of the American Board of Orthodontics will be held at the Statler Hotel in Los Angeles, California, Monday through Saturday, April 23 to 28, 1962. Ortho-

dontists who desire to be certified by the Board may obtain application blanks from the secretary, Alton W. Moore, University of Washington, School of Dentistry, Seattle 5, Washington.

Applications for acceptance at the Los Angeles meeting, leading to stipulation of examination requirements for the following year, must be filed before March 1, 1962. To be eligible, an applicant must have been an *active* member of the American Association of Orthodontists for at least two years.

Central Section of the American Association of Orthodontists

The Central Section of the American Association of Orthodontists will hold its twenty-fourth annual meeting at the Radisson Hotel in Minneapolis, Minnesota, Oct. 1 to 3, 1961. The meeting will be under the direction of Henry E. Colby, president, and Kenneth E. Holland, secretary.

The Executive Committee announces the selection of Drs. Max E. Ernst of St. Paul and Bernard G. deVries of Minneapolis as honored guests at the meeting. Both of these men are charter members of the Central Section and have been members of the American Association of Orthodontists since 1919. Each has been extremely active in the administrative activities of orthodontics as well as the various local, state, and national aspects of the dental profession.

Committee chairmen for the meeting are as follows:

General Arrangements—Robert E. Baker
Program—Sherwood R. Steadman
Exhibits—W. Manfred Jacobsen
Entertainment—Wallace J. Morlock
Ladies' Entertainment—Arthur D. Cummings and Mrs. W. Manfred Jacobsen

The following essayists will appear on the program:

Edward C. Stafne, Rochester, Minnesota
Charles J. Burstone, Indianapolis, Indiana
Harold T. Perry, Jr., Elgin, Illinois
Charles J. Baldwin, Indianapolis, Indiana
Frank S. Ryan, Aurora, Illinois
Lawrence W. McIver, Minneapolis, Minnesota

Great Lakes Society of Orthodontists

It has become necessary to change the dates of the annual meeting of the Great Lakes Society. The meeting will be held Nov. 26 to Dec. 1, 1961, at the Eden Roc Hotel in Miami Beach, Florida.

The following papers will be presented:

Radiographic Interpretation of Temporomandibular Joint Disturbances. William Updegrave, Philadelphia, Pennsylvania.

Diagnostic Procedures for Disorders of the Temporomandibular Joint. Laszlo Schwartz, New York, New York.

Harmonious and Disharmonious Functions of the Temporomandibular Joint's Musculature and Occlusion. John R. Thompson, Chicago, Illinois.

Techniques for Radiographic Surveys of the Temporomandibular Joint. William Updegrave, Philadelphia, Pennsylvania. (Dr. Updegrave will supplement his paper with a table clinic.)

Methods of Treatment of Disorders of the Temporomandibular Joint. Laszlo Schwartz, New York, New York.

The Interrelations of Facial Pattern, Facial Growth, and Function. John R. Thompson, Chicago, Illinois.

Mandibular Ostectomy and Osteotomy. Robert Ponitz, Ann Arbor, Michigan.

Light Wire and Light Forces. Parts I and II. Charles Burstone, Indianapolis, Indiana. (Dr. Burstone will supplement his paper with a table clinic.)

Treatment in the Mixed Dentition. Charles Tweed, Tucson, Arizona.

Treatment in the Adult Dentition. Charles Tweed, Tucson, Arizona.

Cephalometric Analysis for Comprehensive Diagnosis and Special Treatment. Scott Holmes, Muskegon, Michigan.

Other highlights of the meeting will be the presentation of American Board case reports, a symposium by Drs. Updegrave, Schwartz, and Thompson, table clinics, a review of institutional research from 1954 to 1960 by Ben Williams of Columbus, Ohio, business sessions, and installation of new officers.

Social activities will include special luncheons, a fashion show for the ladies, two night club tours, and the president's reception and banquet.

Middle Atlantic Society of Orthodontists

The next meeting of the Middle Atlantic Society of Orthodontists will be held at the Chalfonte-Haddon Hall Hotel in Atlantic City, New Jersey, Oct. 1 to 3, 1961.

Northeastern Society of Orthodontists

The fall meeting of the Northeastern Society of Orthodontists will be held Oct. 29 to 31, 1961, at the Hotel Manger in Rochester, New York. This meeting is rather special, since it will mark the fortieth anniversary of the founding of the Northeastern Society. An appropriate banquet to celebrate this occasion has been scheduled for Monday evening, October 30, in the Grand Ballroom of the Hotel Manger.

The Executive Committee, under the capable chairmanship of Nicholas Ippolito, has prepared a very worth-while scientific program. Among those scheduled to appear as essayists, are such outstanding teachers and clinicians as Edward Martinek, Jacob Subtelny, Frank Lamons, Morris Stoner, Lawrence McKiver, David Ast, and William Biederman. In addition, the Local Arrangements Committee, under the able chairmanship of Barnett Frank, has assembled a splendid grouop of table clinicians who also will cover a wide range of timely subjects.

This will the first time in the forty-year history of the Northeastern Society that it will convene in the beautiful city of Rochester. The ladies are being encouraged to attend. In addition to the fortieth anniversary dinner dance, a tour of Kodak Park has been arranged for the ladies, with a luncheon provided by Eastman Kodak Company. The Northeastern Society is also providing a hospitality room, so that the ladies may be guests of the Society at a continental breakfast. While a great deal of effort has been expended in preparing an outstanding scientific program, the social aspects of the meeting have also been given considerable attention.

During one phase of the meeting, the Rochester Dental Society is planning to honor Leuman Waugh for his outstanding contributions to our specialty. This is particularly appropriate, since Dr. Waugh spent his boyhood in Rochester and it was here that he began his career in dentistry. We in the Northeastern Society of Orthodontists feel honored that Dr. Waugh has been singled out for such recognition.

Excerpts from the Bulletin of the Pacific Coast Society of Orthodontists

CENTRAL COMPONENT

The second meeting of the year was held at the Fairmont Hotel on May 16, 1961. The large percentage of our component members attending is clear testimony to the success of President Don Priewe's plan to devote an entire day to our quarterly meeting. In addition, the facilities of the Fairmont Hotel and excellent speakers have made our meetings outstanding.

The meeting was called to order shortly after 9 A.M. by President Don Priewe. Program Chairman Hugh Carpol then introduced Elbert King of Albuquerque, New Mexico, who discussed "Timing of Orthodontic Treatment."

SOUTHERN COMPONENT

The regular meeting was held on June 9, 1961, at the Statler Hilton Hotel in Los Angeles. The meeting was called to order at 10:05 A.M. by President Linfesty. Sydney Meek reported on the joint meeting to be held in Las Vegas this December. At that meeting J. A. Salzmann will be the featured speaker, and there will also be a talk by Joseph R. Jarabak.

Program Chairman Sydney Meek introduced the speaker of the day, Dr. Perry A. Ratcliff, who gave a most impressive talk on the possible periodontic problems produced by orthodontic appliances and periodontal lesions helped by orthodontic treatment. The enthusiastic question-and-answer period that followed was evidence of the interest in this ably presented subject.

Pacific Coast Society elects new officers

The following new officers have been elected by the Pacific Coast Society of Orthodontists:

President, Herbert V. Muchnic, 435 N. Roxbury Dr., Beverly Hills, California.

President-elect, Eugene E. West, 760 Market St., San Francisco, California.

Vice-president, Malcolm R. Chipman, 1251 Medical Dental Bldg., Spokane, Washington.

Secretary-Treasurer, Warren A. Kitchen, 2037 Irving St., San Francisco, California.

A.A.O. Director, William S. Smith, 2530 Bissell Ave., Richmond, California.

A.A.O. Alternate Director, Warren A. Kitchen.

The Society announces that its next biennial meeting will be held in Las Vegas, Nevada, in February, 1964.

Southern Society of Orthodontists

The next meeting of the Southern Society of Orthodontists will be held Nov. 5 to 8, 1961, in St. Petersburg, Florida. A digest of the program follows.

Sunday, November 5

Registration and recreation.

Monday, November 6

Case Analysis and Treatment Planning. William L. Wilson.
Practical Aspects of Diagnosis in Orthodontics. J. A. Salzmann.
Tooth Position—The Incidental Result of the Reflex Forces of the Dento-Oro-Facial Complex. William A. Buhner.
Functional and Appliance Dynamics in Class II Cases. William L. Wilson.
Principles in Treatment of Class II Malocclusion. J. A. Salzmann.

Tuesday, November 7

Appliance Design and Use in "Borderline Cases." William L. Wilson.
The Responsible Person. J. Wallace Hamilton.
Luncheon honoring new members. (Speaker: Dallas R. McCauley, president of the American Association of Orthodontists.)
Table Clinics (Ed Baker, Chairman).

Wednesday, November 8

What We Know and What We Do in Orthodontics. J. A. Salzmann.
Case Reports. Tyler Haynes, William Ditto, and R. B. Smythe.
Problems and Pitfalls in Orthodontics. William L. Wilson.
Question-and-Answer Period.

Southwestern Society of Orthodontists

The next meeting of the Southwestern Society of Orthodontists will be held at the Sheraton-Dallas Hotel in Dallas, Texas, Oct. 22 to 25, 1961. The program follows:

Sunday, October 22

Registration and recreation.

Monday, October 23

What Is Light Force and Why? Arnold E. Stoller.
Identification of Tongue and Facial Problems. Joseph G. Schurter.
Control of Light Force. Arnold E. Stoller.

Tuesday, October 24

Causes of Neuromuscular Problems and When to Treat Them. Joseph G. Schurter.
Practical Application of Light Force Therapy. Arnold E. Stoller.
Training Program. Joseph G. Schurter.

Wednesday Morning, October 25

Table clinics.

American Dental Association

A special showing of commercial exhibits at the American Dental Association's 102nd annual session in Philadelphia has been arranged for Sunday, Oct. 15, 1961. The official dates of the session are October 16 to 19. The exhibition promises to be the largest and most diversified in Association history, with over 250 exhibitors.

The Sunday exhibition will enable dentists, particularly members of the House of Delegates and others heavily committed during the remainder of the week, to spend several hours examining new products before the official opening of the scientific and business sessions on Monday, October 16. The commercial exhibits, the scientific sessions, and general registration will be at Convention Hall.

A partial list of commercial exhibits was contained in the preliminary program in the August issue of *The Journal of the American Dental Association.* Reprints are available from the Council on Scientific Session, American Dental Association, 222 East Superior St., Chicago, Illinois.

A complete listing of commercial exhibits will be carried in the official program distributed at the time of registration.

National Children's Dental Health Week

The first national network television show in support of National Children's Dental Health Week will be presented by the American Dental Association on Feb. 6, 1962, over the Columbia Broadcasting System.

The program will be sponsored, as a salute to the profession, by Procter and Gamble Company.

There will be no commercials. Instead, all commercial time will be relinquished to the Association for the presentation of dental health education messages.

Starring in the hour-long show, which will begin at 8:30 P.M. E.S.T., will be Henry Fonda.

Details of the program and suggestions on how dental societies may wish to tie it into local Dental Health Week events will be mailed to state and local National Children's Dental Health Week chairmen during September.

American Dental Association holds hospital seminar

The second Advanced Institute on Hospital Dental Service has been announced for Nov. 28 to 30, 1961, in Chicago. The announcement was made by Dr. O. J. McCormack, Chairman of the Council on Hospital Dental Services, American Dental Association.

The Advanced Institute will be sponsored by the American Dental Association in cooperation with the American Hospital Association and will convene in the latter's headquarters in Chicago.

The Advanced Institute is an outgrowth of basic institutes held over the past five years in various cities throughout the nation. These basic institutes presented general principles and standards for the administrative and professional organization of dental services in hospitals. The Advanced Institute will present particular phases of hospital dentistry in

relation to the hospital and to the total health care of the patient. Programs will be offered on legal, administrative, financial and insurance aspects of the topic, and there will be discussions on the relation of the hospital to the total health program of the community.

Program planning is being headed by Dr. Gerard J. Casey, Secretary, Council on Hospital Dental Services, American Dental Association.

First International Conference on Oral Surgery

The First International Conference on Oral Surgery, sponsored by the American Society of Oral Surgeons in conjunction with the Royal College of Surgeons of England, will be held at the Royal College in London, England, July 1 to 4, 1962. All interested dentists and physicians are invited to attend, and a bulletin describing the Conference is available on request. The program will include symposia on the temporomandibular joint and on maxillofacial injuries, in addition to a wide variety of scientific papers and discussion. Approximately one-half of these papers will be presented by essayists from North, South, and Central America, and the other half by essayists from the United Kingdom, Europe, Africa, and Asia. Visitors attending the Conference will also have an opportunity to observe surgical procedures in the hospitals of London as a part of the Conference program.

Extensive social and ladies' programs have been arranged by the Joint British-United States Committee. Features of the social program will be a banquet at London's famed and historic Guildhall and a reception by H. M. Government.

For additional details and bulletin, dentists and physicians in the United Kingdom and Europe should write to Dr. Terence Ward, c/o Royal College of Surgeons, Lincoln's Inn Fields, London, W. C. 2. Dentists and physicians in the United States and other countries should write to Mr. D. C. Trexler, American Society of Oral Surgeons, 840 N. Lake Shore Dr., Chicago, Illinois.

Spanish Society of Orthodontics

The Spanish Society of Orthodontics held its seventh annual meeting April 27 to 30, 1961, at the Faculty of Medicine in Valencia, Spain, under the chairmanship of Dr. Alberto J. Cervera. The Organizing Committee for the meeting consisted of Drs. Manuel Roca Navarro (vice-president), Vincente Ferrandis (secretary), Antonio Martínez Marzal (treasurer), and Amparo Font de Ferrandis (voter).

At the opening session, held at the Official College of Dentists of the Third Region, the following were at the presidential table: His Excellency Jesús Posada Cacho, Civil Governor of Valencia; Dr. Charles Nord, president of the International Dental Federation; Professor Dr. Bartual, representing the Faculty of Medicine; Dr. Pedro López-Malla, president of the College of Dentists; Dr. Costa del Río, president of the Spanish Society of Orthodontics; and Dr. Alberto J. Cervera, president of the seventh annual meeting.

The following papers were presented at the scientific sessions:

Disjunction—Clinical Cases. Enrique Llobell, Valencia, Spain.

Treatment of Angle's Class I and II With Extraction of Four Bicuspids Using the Universal Technique. Antonio Cucalón, Vallejo, California, U. S. A.

Considerations About the Technique of the Extraoral Anchorage Under Neck Gear Anchorage. Ernesto Vilches, Sevilla, Spain.

Functional Application of the Selective Orthodontic Plates. Juan Carol, Barcelona, Spain.

The Edgewise Arch Appliance. Francisco Pérez Fillola, Alicante, Spain.
Indirect Technics to Build Bands and Fixed Apparatuses. Antonio Martínez Marzal, Valencia, Spain.
A Case Treated With Supernumeraries. José Antonio Pagoaga, Madrid, Spain.
The Forces. Differences of Begg, or the Differential Forces of Begg. José Luis Zuriarrain, San Sebastian, Spain.
Generalized Formula for the Cephalometric Facial Model. Hugo Peter Bimler, Wiesbaden, Western Germany.
The Relapse of the Vertical Movements in Orthodontics. Diego Costa del Río, Barcelona, Spain.
The Technics of Fogel-Magill and the Latest Applications of Begg's Principles and Technics of Light Forces. Elliot Silverman, Atlantic City, New Jersey, U. S. A.
The Great Cases of Complicated Malocclusions in Adults. Juan Mañes, Madrid, Spain.
Set-up Technics (the Predetermination of the Models). Juan Canut, Madrid, Spain.
Evolutions in the Techniques of the Edgewise Arch (Angle, Tweed, Jarabak). Saturnino Alvarez, Biosca, Madrid, Spain.
Experiences With the Edgewise Arch. Alberto J. Cervera, Valencia, Spain.
Importance of the Assessment of Photography in Orthodontics. Gilberto Echeverri, Bogotá, Colombia.
Functional Treatment of the Disgnathias. José Luis Galvez, Granada, Spain.
Inclusion and Disinclusion of Canines. Enrique Llobell, Valencia, Spain.
The Orthodontic Treatment and Its Influence on the Apical Bases. Oscar Osorio, Buenos Aires, Argentina.
Inferior Maxillary Prognathism by Macroglossia. Pedro Jover, Madrid, Spain.
Myofunctional Therapy. Amparo Font de Ferrandis, Valencia, Spain.
The Supraclusion of Incisors. Vicente Ferrandis, Valencia, Spain.
The Extensive Lateral Movement of the Upper Incisors in Adult Patients. Juan Mañes, Madrid, Spain.
The Age and Psychology of the Child in the Orthodontic Treatment. Juan de Aroŝtegui, Bilbao, Spain.
The Elastic Ligature of Goldstein. Jacobo Llinás, Barranquilla, Colombia.

In the afternoons there were table clinics showing appliances, cephalometrically analyzed x-ray pictures, clinical cases, etc. The following participants gave demonstrations:

The Edgewise Study Group (Jacobo Llinás, José Luis Zurriarain, José Lobera, Antonio Martínez Marzal, Francisco Pérez, José Antonio Pagoaga, Saturnino Alvarez, and Alberto J. Cervera):
Presentation on Typodonts of the Edgewise Arch Techniques According to Tweed and Jarabak.
Indirect Building Technique of Bands and Complete Fixed Appliances.
Teleradiographic Cephalometric Orthodontic Analysis.
Elastic Ligature of Goldstein.
Case Presentation.

Pepita Blasco, Valencia:
Bracket and Spiral Springs for Bimler's Apparatology.
Simplification of the Twin Arch Assembly of Johnson's Method.
Pressure Bracket for Same.
Plate Gadget for the Gyroversion of the Molars.
Making of the Plaque Anchorage for Single Teeth.

Diego Costa del Río, Barcelona:
Cases Treated With Functional Apparatology.

Juan Canut, Madrid:
Clinic of the Space Maintainers.

Enrique Llobell, Valencia:
Cephalometrics.

Juan Mañes, Madrid:
The Extraction of a Lower Incisor in Order to Correct the Cases of Disproportion in the Size of the Dental Plaques.

Juan Carol, Barcelona:
Orthodontic Apparatology.
Gnathostatic Study of the Results in Extraction Cases.

Peter Bimler, Wiesbaden, Western Germany:
Apparatology of Bimler and Its Prefabricated Pieces.

Antonio Cucalón, Vallejo, California, U. S. A.:
Extraction in Series in the Orthodontic Treatment.
Steiner's Cephalometric Analysis.
Cases of Angle's Class I and II Treated With Extractions of Four Bicuspids using the Technics of the Universal Arch.
Cephalometric Evaluation of the Extraoral Anchorage.

Ernest Pozzi, Vallejo, California, U. S. A.:
Fixed Prosthesis and Orthodontics.

Elliot Silverman, Atlantic City, New Jersey, and Jack H. Bogdanoff, Haddonfield, New Jersey:
Fogel-Magill Technics and Begg's Differential Forces of Thin Wires in the Use of the Edgewise Arch.

P. Ben Johnson, New Kensington, Pennsylvania, U. S. A.:
Treatment of Class III.

Burton H. Hoffman, Buffalo, New York, U. S. A.:
Presentation of Cases and of Treatment Techniques.

The social program had been well arranged by the Organizing Committee. On Wednesday, April 26, there was a reception at the Restaurant Viveros, where participants were welcomed by Dr. and Mrs. Cervera and the other members of the Organizing Committee. At the opening session the College of Dentists offered a Spanish wine, and on the second day of the meeting another wine was offered at the Town Hall by the Mayor and Councillors. The closing banquet was held in the Astoria Hotel, with Dr. Professor Juan Mañes of Madrid acting as master of ceremonies.

The program planned for the ladies included visits to the furniture works of Mariano García, the ceramics factory of Manises, La Hispania, a 5 o'clock tea at the Restaurant of the Gardens of the Royal Ponds, a fashion show organized by the firm of Sagalá in the Gardens of the Royal Ponds, museum visits, and a visit to the Silk Exchange.

On Sunday, after three days of hard work, there was a "gastronomical-touristical-Valencian" day, which began with Mass in the Chapel of the Holy Cup of The Last Supper in the Cathedral of Valencia. This was followed by a trip to Alcira, where visitors admired the orange groves and the vista of the whole Jucar Valley with its citrus woods. After a visit to the Avidose Farm with its ultramodern fowl-raising installation, the group went to Gandía. There, at the Bayrén Hotel, the typical rice plate of the Valencian region and other regional dishes were served. The party returned by way of the coastal road, where the scent of orange blossoms filled the air, past green rice fields, by the only big lake in Spain (the Albufera), and along the pine woods of Saler.

The eighth annual meeting of the Society will be held in Seville, under the chairmanship of Dr. Ernesto Vilches. Dr. José Lobera Rubio will preside over the 1963 meeting, which will be held in Zaragoza.

Lancaster Cleft Palate Clinic

Graduate trainingship grant awards through the Department of Health, Education, and Welfare, National Institute of Dental Research, are available to qualified persons in the fields of medicine, dentistry, speech, and special education.

The course, which will be given Oct. 9 to 12, 1961, deals with the habilitation/rehabilitation program of persons with oral-facial-speech handicaps.

All inquires concerning the program should be addressed to Robert T. Millard, Program Director, Lancaster Cleft Palate Clinic, 24 N. Lime St., Lancaster, Pennslyvania.

Columbia University

The School of Dental and Oral Surgery announces the following courses for qualified orthodontists:

Twin-Wire Appliance Therapy. Dec. 4 to 8, 1961. Joseph E. Johnson and associates.

Edgewise Appliance Therapy. March 5 to 10, 1962. Clifford L. Whitman and associates.

Applied Roentgenographic Cephalometry. March 14 to 16, 1962. Henry I. Nahoum.

Segmented Arch Technique. April 2 to 6, 1962. Charles J. Burstone and associates from the University of Indiana.

For further information, write to Dr. Joseph A. Cuttita, Chariman, Postgraduate Admissions, Columbia University School of Dental and Oral Surgery, 630 West 168th St., New York 32, New York.

Washington University

Washington University School of Dentistry announces that a course in the "Twin-Wire Technic" will be given Oct. 9 to 13, 1961, under the direction of Dr. Joseph E. Johnson. The course will begin at 8:30 A.M. on Monday, October 9, at the School of Dentistry, 4559 Scott Ave., St. Louis, Missouri.

University of Kansas City

The University of Kansas City School of Dentistry will hold its second annual orthodontic seminar at the Camelback Inn in Phoenix, Arizona, Nov. 5 to 8, 1961.

Lenox Hill Hospital

Future meetings of the Orthodontic Staff of the Lenox Hill Hospital in New York City will be held at 8:15 P.M. in the Doctor's Lecture Hall as follows:

Wednesday, Oct. 25, 1961

Therapy as Advocated by Richard Barrett. Florence A. Glatt, speech therapist.

Wednesday, Jan. 24, 1962

Dr. Viken Sassouni, speaker.

Wednesday, April 25, 1962

Dr. James Jay, speaker.

Notes of interest

Ali M. Aram, D.M.D., announces the opening of his office at 540 Lynn Fells Parkway, Melrose, Massachusetts, practice limited to orthodontics.

Joseph Bass, D.D.S., announces the continuation of the orthodontic practice of the late Dr. John E. Sage at the Flushing Medical Building, 42-27 Union St., Flushing, New York.

Carmine A. Durzo, D.D.S., M.S., announces the opening of his office at Mosside Medical Building, 2545 Mosside Blvd., Monroeville, Pennsylvania, practice limited to orthodontics.

Leonard S. Fishman, D.D.S., announces the opening of his office for the exclusive practice of orthodontics at 717 East Genesee St., Syracuse, New York.

Martin S. Goldberg, D.D.S., M.S.D., announces the opening of his office at 34 South High St., West Chester, Pennsylvania, practice limited to orthodontics.

James G. Rayes, D.D.S., M.S., announces the opening of his office at 11 North Jefferson St., Clearwater, Florida, practice limited to orthodontics.

Robert M. Rubin, D.M.D., M.S., announces the opening of his office for the practice of orthodontics at Suite 10, Glover Professional Bldg., 110 Maycox Ave., Wards Corner, Norfolk, Virginia.

Richard R. Rutter, D.D.S., announces the opening of his office at 777 Welch Rd., Palo Alto, California, practice limited to orthodontics.

Kenneth K. Shephard, D.D.S., announces the removal of his office to 511 Citizens Bldg., West Palm Beach, Florida, practice limited to orthodontics.

Jack E. Sturdivant, D.D.S., M.S., announces his association with Maynard A. Ukena D.D.S., M.S., at 614 Kellog Ave., Ames, Iowa, practice limited to orthodontics.

Dr. Clifford L. Whitman and Dr. Cornelius A. McGlennon announce the removal of their office to 940 Main St., Hackensack, New Jersey, practice limited to orthodontics.

Forthcoming meetings of the American Association of Orthodontists:

1962—Statler Hotel, Los Angeles, California, April 28 to May 3.
1963—Hotel Fontainebleau, Miami Beach, Florida, May 5 to 9.
1964—Palmer House, Chicago, Illinois, May 10 to 14.
1965—Dallas Statler-Hilton, Dallas, Texas, April 25 to 30.

*Officers of Orthodontic Societies**

The *American Journal of* ORTHODONTICS is the official publication of the American Association of Orthodontists and its component societies. The Editorial Board of the JOURNAL is composed of a representative of each of the component societies.

American Association of Orthodontists *Next meeting April 28–May 3, 1962, Los Angeles*

President, Dallas R. McCauley, 410 South Beverly Dr., Beverly Hills, Calif.
President-Elect, J. A. Salzmann, 654 Madison Ave., New York, N. Y.
Vice-President, J. Lyndon Carman, 501 Republic Bldg., Denver, Colo.
Secretary-Treasurer, Earl E. Shepard, 225 South Meramec, Clayton, Mo.

Central Section of the American Association of Orthodontists *Next meeting Oct. 1-3, 1961, Minneapolis*

President, Henry E. Colby, 1850 Medical Arts Bldg., Minneapolis, Minn.
Secretary-Treasurer, Kenneth E. Holland, 1016 Sharp Bldg., Lincoln, Neb.
Director, G. Hewett Williams, 811 Elm St., Winnetka, Ill.

Great Lakes Society of Orthodontists *Next meeting Nov. 26–Dec. 1, 1961, Miami Beach*

President, Paul V. Ponitz, 914 Security Bank Bldg., Battle Creek, Mich.
Secretary, Edward A. Cheney, 2900 Grand River, Lansing, Mich.
Director, Harlow L. Shehan, 601 Jackson City Bank Bldg., Jackson, Mich.

Middle Atlantic Society of Orthodontists *Next meeting Oct. 1-3, 1961, Atlantic City*

President, Paul V. Reid, 1501 Medical Arts Bldg., Philadelphia, Pa.
Secretary-Treasurer, Charles S. Jonas, Mayfair Apts., Atlantic City, N. J.
Director, Louis E. Yerkes, 825 Linden Ave., Allentown, Pa.

Northeastern Society of Orthodontists *Next meeting Oct. 29-31, 1961, Rochester, N. Y.*

President, Irving Grenadier, 888 Grand Concourse, New York, N. Y.
Secretary-Treasurer, David Mossberg, 36 Central Park S., New York, N. Y.
Director, Norman J. Hillyer, 230 Hilton Ave., Hempstead, L. I., N. Y.

Pacific Coast Society of Orthodontists *Next meeting February, 1964, Las Vegas*

President, Herbert V. Muehnie, 435 N. Roxbury Dr., Beverly Hills, Calif.
Secretary-Treasurer, Warren A. Kitchen, 2037 Irving St., San Francisco, Calif.
Director, William S. Smith, 2530 Bissell Ave., Richmond, Calif.

Rocky Mountain Society of Orthodontists

President, Louis J. Williams, 9th & Center Sts., Casper, Wyo.
Secretary-Treasurer, Hubert J. Bell, Jr., 230 Mercantile Bank Bldg., Boulder, Colo.
Director, Louis J. Williams, 9th & Center Sts., Casper, Wyo.

Southern Society of Orthodontists *Next meeting Nov. 5-8, 1961, St. Petersburg*

President, Charles E. Harrison, 362 Sixth St., S., St. Petersburg, Fla.
Secretary-Treasurer, William H. Oliver, 1915 Broadway, Nashville, Tenn.
Director, Boyd W. Tarpley, 2118 Fourteenth Ave., S., Birmingham, Ala.

Southwestern Society of Orthodontists *Next meeting Oct. 22-25, 1961, Dallas*

President, Bibb Ballard, 7713 Inwood Rd., Dallas, Texas
Secretary-Treasurer, Tom M. Matthews, 8215 Westchester Dr., Dallas, Texas
Director, Nathan Gaston, 701 Walnut St., Monroe, La.

American Board of Orthodontics *Next meeting April 23-28, 1962, Los Angeles*

President, J. A. Salzmann, 654 Madison Ave., New York, N. Y.
Vice-President, B. F. Dewel, 708 Church St., Evanston, Ill.
Secretary, Alton W. Moore, University of Washington School of Dentistry, Seattle, Wash.
Treasurer, Paul V. Reid, 1501 Medical Arts Bldg., Philadelphia, Pa.
Director, Frank P. Bowyer, 608 Medical Arts Bldg., Knoxville, Tenn.
Director, Nathan G. Gaston, 701 Walnut St., Monroe, La.
Director, Richard M. Railsback, 1333 Grand Ave., Piedmont, Calif.

*In order to keep this list up to date, the editor depends on the various sectional editors to notify him immediately of changes in officer personnel.

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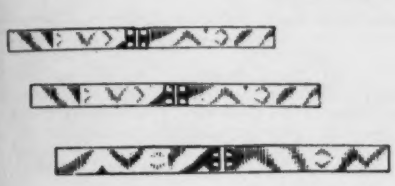

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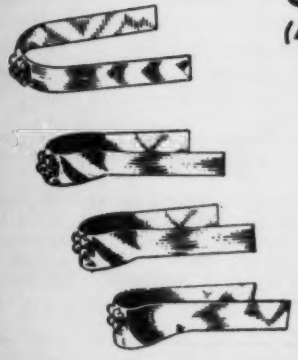

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C. Philip Adams "The Design and Construction of Removable Orthodontic Appliances." New Revised 2nd Edition. $5.50.

P. R. Begg "Differential Force in Orthodontic Treatment." Reprint from A.J.O. July, 1956. 4 Reprints, 1954 A.J.O. All 5 Reprints. $6.00.

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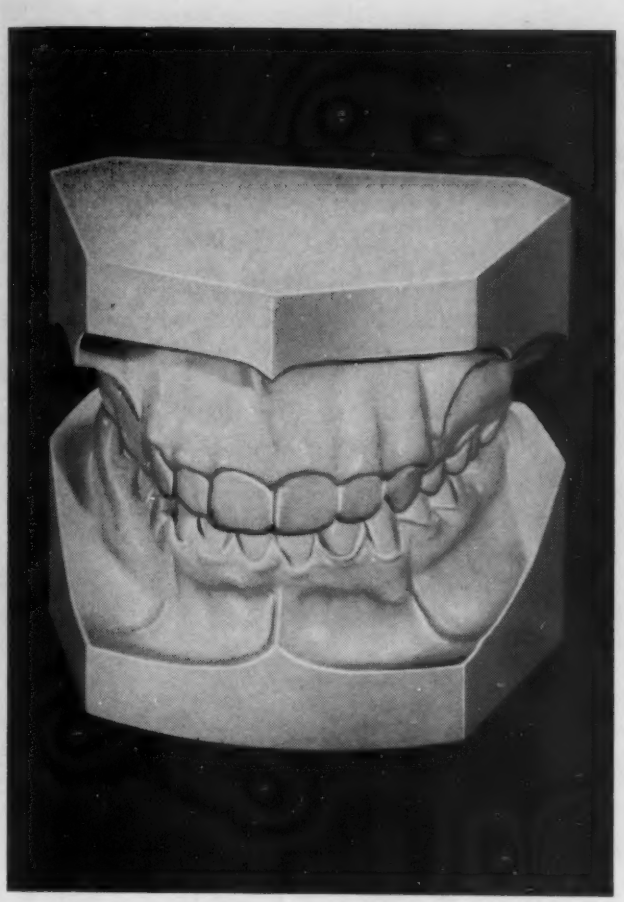

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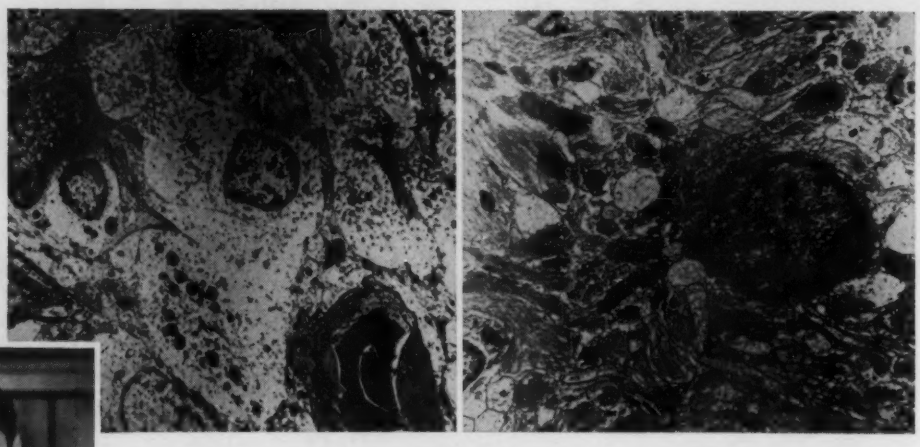
Fig. 1322. Electron micrograph of oligodendroglioma. Several neoplastic cells with abundant pale cytoplasm are arranged near a blood vessel (lower right). Mitochondria are especially prominent in cell at left of blood vessel. (x5,000.) (Courtesy Dr. Sarah Luse.) This illustration appears 40% larger in the book.

Fig. 1325. Electron micrograph. Cellular processes and cells forming this optic nerve glioma are strikingly similar to those of gliosis. From child 6 years of age. (x7,000.) (Courtesy Dr. Sarah Luse.) This illustration appears 40% larger in the book.



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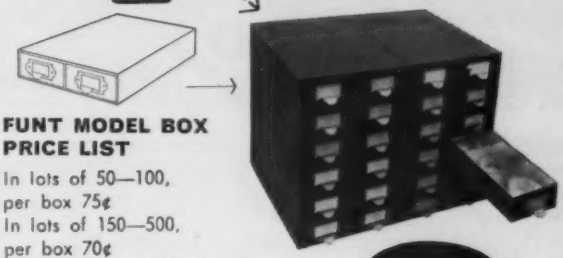

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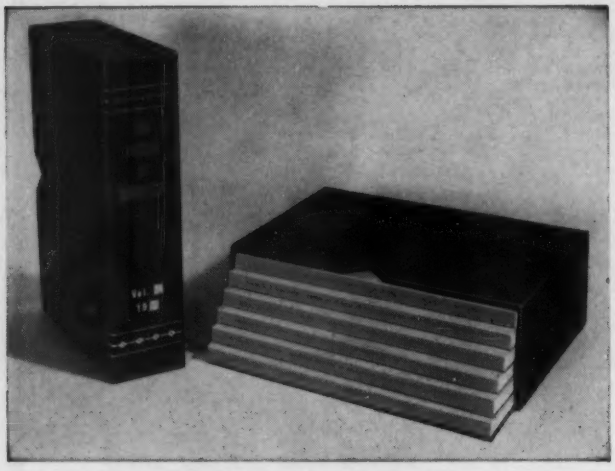

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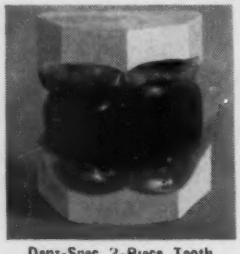

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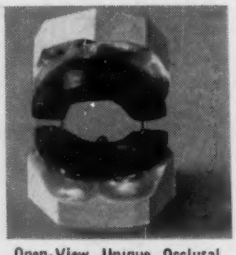

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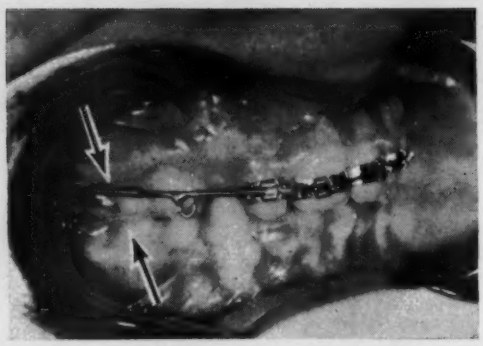

Fig. 141. Combination of compressed coil-spring and intermaxillary elastic traction used in posterior molar movement.

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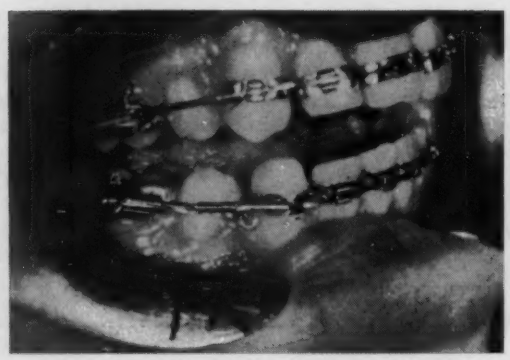

Fig. 131. A, Space closer used on end section of mandibular twin-wire labial arch.

Fig. 131. B, Space closer used on end section of maxillary twin-wire labial arch.

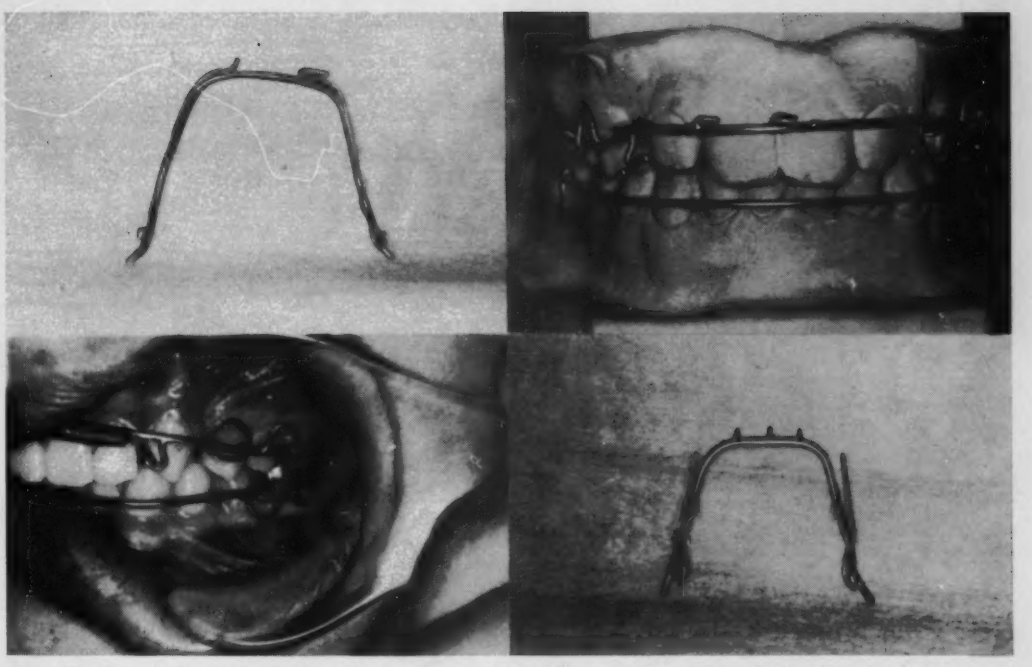

Fig. 182—Top, Left: Left, horizontal posterior curved auxiliary spring. Right, horizontal posterior recurved auxiliary spring. *Fig. 183*—Top, Right: Labial appliance with perpendicular curved auxiliary springs and intermaxillary rubber band hooks of .035 wire. *Fig. 184*—Bottom, Left: Left to right, labial arch with horizontal right angle auxiliary spring, intermaxillary hook, perpendicular loop auxiliary spring, mandibular rubber band hook and labial arch tied in at buccal tube. *Fig. 185*—Bottom, Right: Left and right, horizontal posterior recurved auxiliary spring. Center, perpendicular straight auxiliary spring.

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By BOYD W. TARPLEY, B.A., D.D.S., Professor and Chairman, Department of Orthodontics, University of Alabama School of Dentistry, Birmingham, Ala.

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